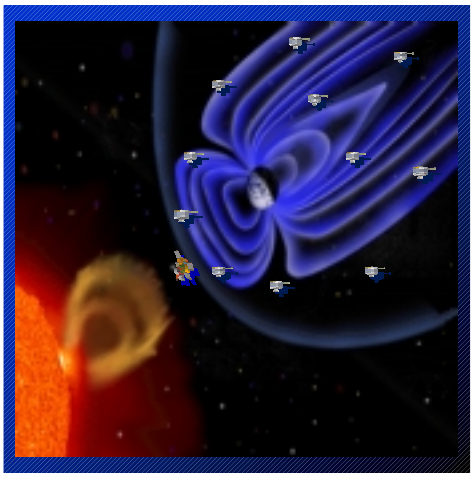
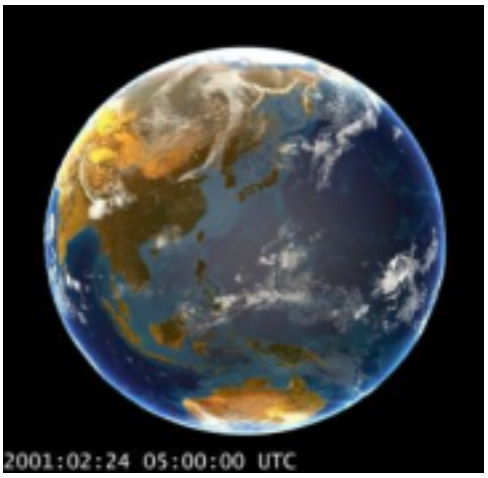
Information Systems Center





Highlights 2000 – A Year In Review

Applied Engineering and Technology Directorate (AETD)
Information Systems Center (ISC)
Code 580
http://isc.gsfc.nasa.gov

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Executive Summary

The Information Systems Center (ISC) had a very productive and challenging calendar year 2000. With over 300 information technology (IT) and engineering professionals, the ISC continued to provide crucial support to the Flight Projects Directorate as well as both the Earth and space science communities on a wide range of missions, initiatives, technologies and formulation activities.

This year saw the launch of the Image/Magnetopause to Aurora Global Explorer (IMAGE) on March 25 and the Earth Observing-1 (EO-1)/SAC-C spacecraft on November 21. The Imager for the IMAGE mission was the first in a series of medium class Explorers dedicated to imaging the Earth's magnetosphere, a region of space controlled by the Earth's magnetic field and containing extremely tenuous plasmas of both solar and terrestrial origin. The ISC provided significant support to the development of the ground systems and the science data processing system for the Low Energy Neutral Atom (LENA) instrument, as well as support to the Coordinated Data Analysis Web (CDAWeb) system that is part of the National Space Science Data Center (NSSDC). The IMAGE mission is one of the first missions to embrace the open data policy where data is available to the space science community and general public at the same time it is available to mission scientists. EO-1 was the first Earth looking mission in the New Millennium Program, designed to validate advanced land imaging instrument technologies for space-based Earth observation. EO-1 is flying in formation with Landsat-7 and collects over 50 calibration and land images weekly. The ISC provided major support to EO-1 in the area of ground system development, flight software technical (recovery) management, instrument integration and test, and data processing and development of the Enhanced Formation Flying software with Landsat-7. The ISC also provided leadership in the technical direction in recovering the EO-1 flight software.

The ISC also provided major support to many other missions. The details in the following pages demonstrate the breadth and depth of the ISC team skills and the wide range of supported projects. In addition to missions that are in formulation and development, the ISC played a major role in the operations management and sustaining engineering and operation of GSFC's many on-orbit missions. GSFC operates 18 on-orbit missions. Particular note is made for the success of the Hubble Space Telescope (HST) and Terra operations over this past year, employing a new Vision 2000 control center system and 486 support system flight software for HST and the new mission and science ground systems for Terra. ISC personnel provide expertise in anomaly resolution, special maneuvers, and overall mission planning. Year 2000 saw the successful de-orbit of the Compton Gamma Ray Observatory (CGRO) on June 4 and maneuvers conducted for WIND orbit change and the continued successful operation of the SOHO spacecraft without gyros. For EO-1, there were several important on-orbit changes that greatly improved the science output and operational performance of the spacecraft: (1) development of operational procedures to improve the performance of the X-Band downlink and; (2) flight software patches to allow the Short Wave Infrared (SWIR) instrument to operate at a greater duty cycle (80 percent vs. 50 percent) by bypassing the Hyperion cryocooler sensor failure.

Executive Summary (Cont'd)

Our skilled and dedicated efforts also focused on development of future missions. In particular, the year 2000 saw progress in the development of the ground system and flight software for Aqua, Aura, Gamma-ray Large Aperture Space Telescope (GLAST), Microwave Anisotropy Probe (MAP), National Polar Orbiting Environmental Satellite System (NPOESS), Net Primary Production (NPP), Space Technology-5 (ST-5), Ice, Clouds, and Land Elevation Satellite (ICESat) and Triana. Support to the science labs continued with the development of application specific software for the purpose of analysis and display of mission science data, for example, the development of the Space Weather View (SWV) for the Community Coordinated Modeling Center (CCMC).

The ISC is committed to GSFC's goals of technology investment. This commitment was evidenced in the ISC's major strides in developing and winning technology proposals, holding workshops to encourage collaborative thinking and idea generation; and developing processes and procedures to better facilitate the approval of papers and proposals. Winning proposals were submitted to various NASA Research Announcement (NRA) and Independent Research and Development (IRAD) calls. The ISC also submitted over 30 papers to various technical and special interest conferences. The ISC held it's yearly Software Engineering Workshop (SEW) in November, which had an attendance of over 230. The ISC also held its first Science Data Processing Workshop (over 200 attendees) that invited both the space and Earth science communities to explore areas of common concern. This was considered a great success and planning has already started for a follow-on workshop in 2001.

Even with many great success stories, the year 2000 was not without its challenges. Declining and erratic budgets caused disruptions in workflow and created an environment that continually had the management team replanning. The loss of key personnel created mission concerns and necessitated reassignments of personnel to cover critical areas, sometimes leaving other areas thinner than desired. Hiring continued to be a major challenge as the ISC Management Team worked diligently to attract recent graduates in the IT area, even developing a brochure that describes the many great reasons for working at GSFC.

With our many successes and the challenges of our future missions, the ISC looks forward to 2001 and beyond to lead in providing our customers and partners in enabling information systems to explore and advance scientific knowledge. Just look at what we have accomplished!

Mission and Strategy

To provide high value information systems products, services, and expertise, and to advance information technologies, which are aligned with customer needs.

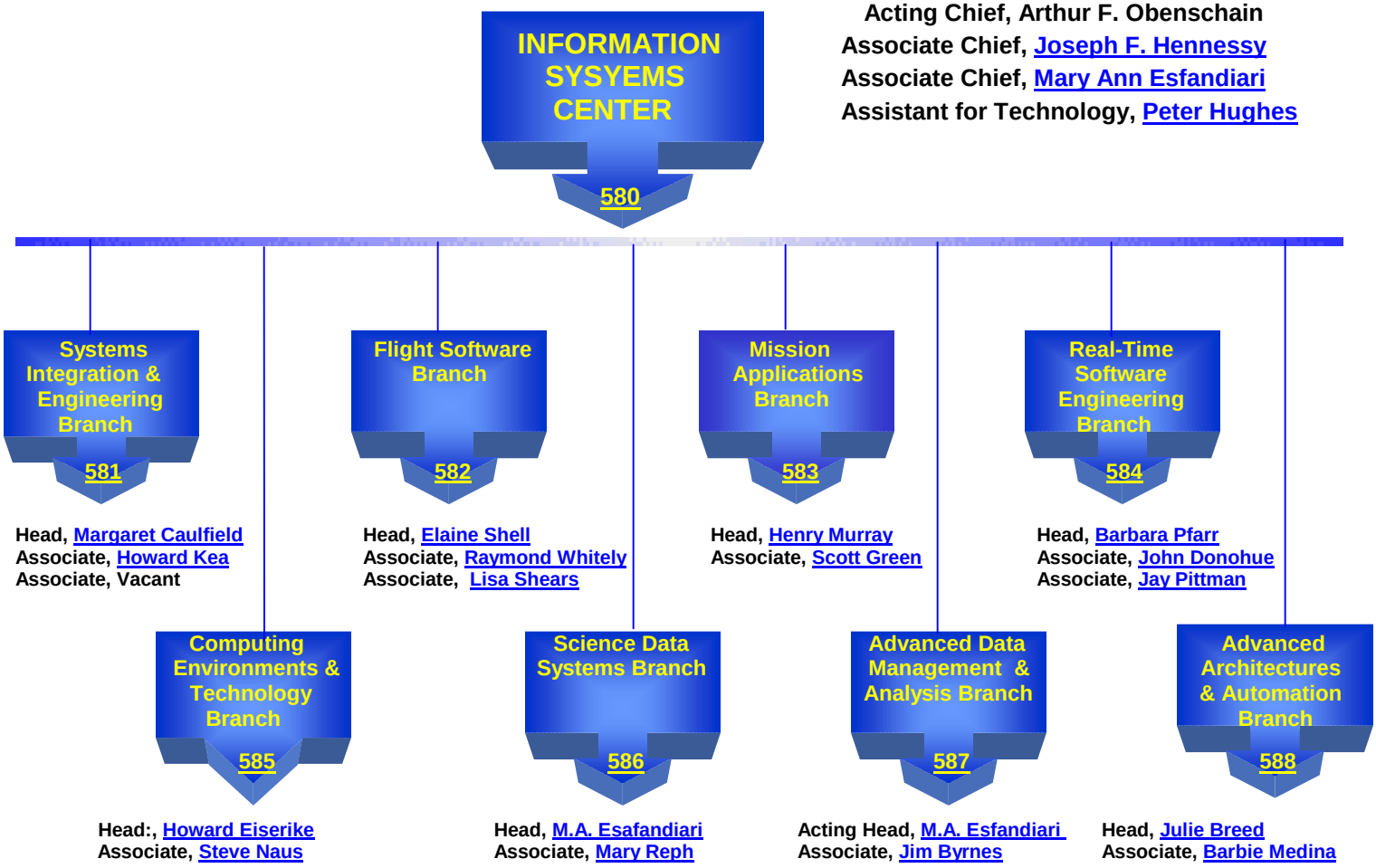
The ISC is an innovative center of expertise in the formulation and implementation of information systems in support of National Aeronautical and Space Administration (NASA) programs and projects, specifically the GSFC Earth Sciences, Space Sciences, and Technology focus area. The ISC collaborates with the science community, projects and other customers to meet their information systems and technology needs through the design, implementation, and integration of information systems and data system components. The ISC provides technology, capability and products in design, development, implementation, test, integration and operations. Additionally, the ISC provides leadership and vision in identifying and sponsoring new and emerging information systems technologies.

The ISC has five primary strategy objectives:

- Deliver high value products and services that satisfy customer needs
- Advance leading edge information systems technology
- Build a diverse, talented, innovative, energized, sought after workforce of employees and managers
- Establish open, flexible, collaborative relationships with customers and partners
- Build a cohesive, “no walls” organization with effective inter and intra branch communication and collaboration

Organizational Structure

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
Applied Engineering and Technology



The Systems Integration and Engineering (SIE) Branch provides expert advice and technical consultation to Principle Investigators and Mission Study Managers on operational concepts, data systems architectures and life cycle costing. It provides end-to-end engineering of ISC mission systems development activities, including software development and flight operations. It provides expert consultation on software process improvements, technology assessments and product evaluation.

Management Team:

Branch Head	**Associate Branch Heads**	
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SEW25 - 25th Anniversary of the Software Engineering Workshop (SEW)

On November 29 and 30 2000, the Software Engineering Laboratory (SEL)—a consortium composed of the ISC, Goddard, the University of Maryland (UMD), and Computer Sciences Corporation (CSC)—presented the 25th Annual SEW. Although registrations (263) and attendance (232) for the two-day conference were slightly lower than the preceding year, the 199 registrations for the tutorials—a new SEW feature—made up for the shortfall many times over. The three tutorials—*Requirements, Reading and Reliability* (53 registrants), *Understanding Software for Project Management* (52 registrants), and *Software Process Improvement* (94 registrants) were held on November 28.

Two Europeans presented papers at SEW25, one from the University of Rome and the other from Linkoeping University in Sweden. In addition 19 attendees represented 7 foreign countries: Canada, Brazil, the United Kingdom, Germany, Spain, Russia, and Japan. Thirty-eight percent of all attendees described themselves as government employees, 16 percent as academics, and 48 percent as members of industry. The 38 percent from government consisted of 13 percent from the ISC, 3 percent from other parts of GSFC, 3 percent from other NASA Centers, and 19 percent from other government agencies.

The first day of papers began with a session entitled, "*The Software Engineering Laboratory*." SEL Director Mike Stark presented "*Supporting Development of Satellite's Guidance Navigation and Control Software: A Product Line Approach*." CSC's Dave Schultz presented the paper "*A Matrix Approach to Software Process Definition*." Vic Basili, a SEL founding member from the University of Maryland (UMD), presented "*CeBaSE: The Center for Empirically-Based Software Engineering*."

From left to right: Vic Basili (UMD SEL Founding Member), David Schulz (CSC), and Mike Stark (GSFC SEL Director)

This session was followed by the Empirical Models session. After the lunch break the audience was treated to three papers on Modeling Processes. The first day concluded with a panel session on the Earth Observing System (EOS) Data and Information System (EOSDIS). Dawn Lowe of Goddard moderated and panelists Mike Moore (Goddard), Curt Shroeder (Goddard), and Steve Fox (Raytheon) discussed lessons learned from EOSDIS. This panel session was extremely well received by the audience. Afterwards attendees were invited to the Goddard Visitors Center for the SEW25 reception. This usually tranquil museum came alive with the sounds of the Goddard quartet "On the Rocks" and the tastes of abundant delicious *hors d'oeuvres*.

The second day of papers opened with an excellent keynote speech, "*The Future of Software at NASA*" given by Orlando Figueroa, the NASA Deputy Chief Engineer for Systems Engineering. This was followed by a paper session entitled, "*Experience*." The Quality Mission Software panel discussion, which kicked off the afternoon session, featured Rich Doyle and John Kelly, from the Jet Propulsion Laboratory (JPL) and Charles Vanek from NASA's Goddard. The final paper session was "*Reusable Architecture*."

NASA's Deputy Chief Engineer for Systems Engineering, Orlando Figueroa

One hundred of the 232 attendees completed the SEW25 questionnaire, a 43 percent sample. The SEW received high marks for the quality of the presentations and the environment. Ninety-two percent stated that the general content was either very good (the highest of the five ratings) or good. Eighty-eight percent rated the level of interest as either very good or good. Sixty-five percent rated the level of academic rigor as either very good or good. Visual presentation, verbal/audio presentation, logistical support, and physical comfort received respectively 81 percent, 74 percent, 92 percent, and 73 percent in the very good or good categories.

When asked what features they would like to see at SEW26, respondents most frequently asked for handouts of slides (71 percent), which were a new SEW item this year. This request was followed by requests for keynote speakers (68 percent), tutorials (66 percent), traditional talks (64 percent) and panels (56 percent).

The SEL has debated whether to move the SEW off site in order to provide better accommodations. Attendees were asked if they would attend SEW26 if it were held off site for this reason and if the registration fee were raised to $150 - $200. The response was nearly evenly split. Forty-seven percent replied that they would attend SEW26 under these circumstances. Fifty-three percent replied "no."

From left to Right: Howard Kea (NASA's GSFC), Mary Ann Esfandiari (NASA's GSFC), Trisha Jansma (JPL), and John Kelly (JPL)

Highlights from the Compton Gamma Ray Observatory (CGRO) Mission

The CGRO was the second of NASA's Great Observatories following the Hubble Space Telescope (HST). Named in honor of Dr. Arthur Holly Compton, CGRO made invaluable contributions to the field of high-energy astrophysics during its 9-year mission.

At 17 tons, CGRO was the heaviest astrophysical payload ever flown at the time of its launch on April 5, 1991, aboard the space shuttle Atlantis. After exceeding its mission life by more than 4 years, CGRO was safely de-orbited and reentered the Earth's atmosphere on June 4, 2000.

CGRO had a diverse scientific agenda, which included studies of some of the universe's most energetic celestial phenomena: solar flares, gamma-ray bursts, pulsars, nova and supernova explosions, accreting black holes of stellar mass, quasar emission, and interactions of cosmic rays with the interstellar medium.

CGRO carried a collection of four instruments that together could detect an unprecedented range of high-energy radiation called gamma rays. These instruments were the Burst and Transient Source Experiment (BATSE), the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMPTEL), and the Energetic Gamma Ray Experiment Telescope (EGRET). Covering an unprecedented six decades of the electromagnetic spectrum (from 30 keV to 30 GeV), CGRO's four instruments were ten times more sensitive than any predecessors flown on previous missions.

CGRO detected more than 400 gamma ray sources, ten times more than what was previously known. It recorded more than 2,500 bursts—before CGRO, only about 300 had been detected. CGRO discovered that gamma-ray bursts come uniformly from all directions in the sky. This indicates that the bursts are not confined to our galaxy, but are probably due to huge explosions in the distant reaches of the universe. Using data from CGRO, scientists were able to determine that half of the previously unidentified high-energy gamma ray sources in our galaxy actually comprise a new class of mysterious objects. Other major accomplishments of CGRO were:

CGRO detected five new black hole systems in our galaxy with transient gamma-ray emission from in falling gas.

- Using gamma radiation from 26-Al decay, CGRO created a map of the sites of nucleosynthesis in our galaxy over the past million years.

- CGRO detected gamma-ray quasars with high-energy gamma-ray emission from jets of particles emanating from massive black holes.

- CGRO measured the distribution of positron antimatter in our galaxy.

ISC Information Systems Center Flight Software

The Flight Software (FSW) Branch provides end-to- end life cycle products associated with embedded software for spacecraft, scientific instruments, and flight components.

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The year 2000 was a very good year for the FSW Branch in terms of well-deserved staff recognitions, highly effective mission FSW support, and Branch initiatives. We also demonstrated, via crisis recoveries on the Earth Observing (EO-1) and InfraRed Array Camera (IRAC) FSW efforts, the essential end-to-end systems engineering and development "non-negotiables" of FSW. These last efforts represent the predictable results of inadequate engineering, testbeds, staff, processes, controls and organizational visibility during FSW developments. Ray Whitley was the driving force during recovery of both EO-1 and IRAC, with Ken Rehm, Louise Bashar and a dedicated set of excellent FSW contractors supporting them. The IRAC effort continues to be a challenge.

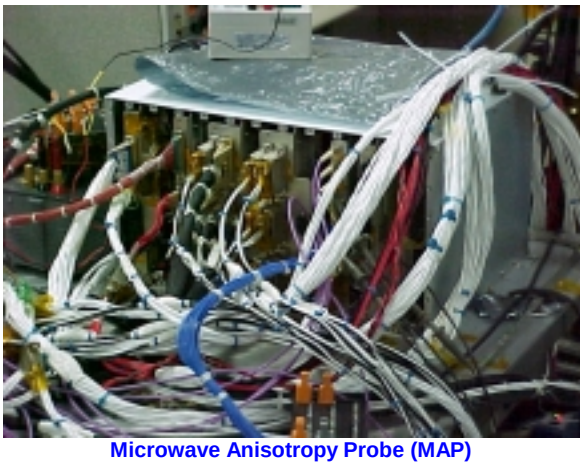
FSW is now fully recognized as a very high risk, mission critical product. The ISC and AETD have both stated the criticality of strong civil servant (and contractor) FSW talent at GSFC. In response to this the FSW Branch was authorized to hire a third Associate Branch Head as well as a Senior FSW Systems Engineer as technical staff to the Branch. FSW at GSFC is a growing specialty.

FSW Branch Mission Development Highlights

The astonishing performance of the entirely new Hubble Space Telescope (HST) 486 FSW system was installed on-orbit during Servicing Mission 3A in December 1999. Full HST science operations were resumed immediately following orbital verification during January. The goals, to exceed the previous on-orbit performance while taking advantage of the more powerful flight computer to provide new functionality, were completely achieved. The team met each major milestone of the original 5-year development schedule with absolutely no delays! The newly obsolete DF224 flight computer from our FSW testbed was given to Dave Simpson for 10 years of supporting hundreds of updates and on-orbit events.

The Microwave Anisotropy Probe (MAP) FSW Team completed acceptance testing of the FSW on all six-flight computers a full year prior to launch. The team, led by Jane Marquart with Maureen Bartholomew responsible for

the overall FSW Test Program, was acknowledged by the Red Team for the quality of their processes and people. During the last year the team developed and tested a contingency build to accommodate alternate star trackers, tested the flight telemetry monitors and command sequences, and supported numerous simulations and integration and test (I&T) activities.



Microwave Anisotropy Probe (MAP)

The Next Generation Space Telescope (NGST) FSW Team, led by Leslye Boyce and Ken Rehm, made terrific progress in defining the flight hardware and software architectures for the common Command and Data Handling (C&DH) elements for NGST. They have worked with the Science Institute in Baltimore and two competing contractors, both working mission designs, to establish mission operability strategies and FSW subsystem interface requirements. Supporting parallel designs of the instrument module enabling us to accommodate each contractor's proposal has been quite a challenge. The down select of prime contractors will occur during the fall of 2001. They have chosen Rational Rose as the integrated development tool for FSW. The FSW on NGST is appropriately recognized as a significant risk area deserving of the highest levels of project visibility.

The Ice, Clouds, and Land Elevation Satellite (ICESat) Geoscience Laser Altimeter Systems (GLAS) Instrument FSW represents our first experience with an Rapid Spacecraft Development Office (RSDO) (i.e., "off the shelf" spacecraft) contractor relationship. The fixed instrument interfaces to the spacecraft made for some difficult interface negotiations, and the sharing of the Engineering Test Unit (ETU) with the I&T effort has delayed FSW testing beyond the desired schedule. However, the FSW led by Manuel Maldonado has been delivered to I&T with full functionality on both the Mongoose V and the Digital Signal Processing (DSP) FSW systems.

While we were enthusiastic about supporting the NGST Nexus demonstration mission, its cancellation during November will give us considerably more flexibility to staff continuing Branch commitments.

FSW Development Systems Management Oversight and FSW "Independent Verification and Validation" (IV&V)

Earth Observing System (EOS) Terra, Aqua and Aura

The highly successful on-orbit performance of the Terra mission FSW, following the December 1999 launch, results from the outstanding FSW leadership of Lisa Shears during the 6-year Lockheed Martin development effort. It also represents the quality of the independent FSW Test Program provided by Tom Clement's Verification and Validation (V&V) Team. Tom's

team has taken over the on-orbit maintenance of the Terra FSW with several important updates already to their credit.

With the designation of the West Virginia (WVA) IV&V organization as the sole NASA group doing "IV&V", we've had to change the name of our EOS V&V Program to "Project V&V". Tom Clement's team is actively working the EOS Aqua Project V&V in preparation for a summer 2001 launch, and the memorandum of understanding (MOU) for the EOS Aura Project V&V is ready for signature. Barbara Scott and Carver Audain, Aqua and Aura FSW Systems Managers, have led resolutions of many interface, delivery, performance and contractor staffing issues with project level appreciation for their significant contributions.

National Polar Orbiting Environmental Satellite System (NPOESS) Preparatory Project (NPP)

The main activity for NPP for FY00 was the December release of the RSDO Request for Offer (RFO) Study #2. The main objectives of this study activity were to establish a refined base-line of NPP satellite requirements, and to develop a preliminary design of the integrated RSDO catalog Core Bus and mission-unique modifications required for the NPP satellite. Proposals were due by 01/19/01. An evaluation team (for which Lisa Shears was a member) reviewed the proposals selecting two to three contractors to proceed with the development of NPP satellite Preliminary Design Reviews (PDRs) in the November 2001 timeframe.

The main contributions have been coordinating the development of the RFO package for Study #2, which includes the Statement of Work (SOW), developing the Level 3 Requirements for the NPP Satellite software, and supporting the Level 3 Operations Concept development. Referring to work done on EOS Terra and the EOS Common Spacecraft, and taking into account lessons-learned has helped define Study #2 SOW activities and hone the requirements and Operations (Ops) Concept definition for NPP.

HST Payload

In 2001, The HST Flight Software Team will be preparing for the 2nd half of the 3rd Servicing Mission (i.e., SM3B), which is scheduled for November 2001. During the SM3B Servicing Mission, several power system components including new solar arrays, Diode Boxes, and Power Control Units will be installed. The FSW Team will provide new Diode Box Software Charge Control--to control the Solar Array Panel connection AND disconnection to the batteries—which will enhance the HST power subsystem operations.

Flight Software Branch Hands-on Technology Initiatives

In order to take advantage of new software and standards technologies with low risk to a mission, the FSW Branch prefers to evaluate options for the future in the safety of ground prototypes. The activities are being pursued by the FSW Branch using the Branch FSW Technologies Lab in Building 14, Room N287. The lab is set up with three flight environments including Mongoose-V, PowerPC750 and UT69R000 processor-based data systems. Todd Miller/582 leads these Branch activities.

Portable Operating System Interface (POSIX) Flight Software Initiative

The goal of this initiative is to investigate the IEEE POSIX standards for future explorer class missions. POSIX is a set of standards, which promotes portability across the multiple operating systems. Using a POSIX compatible operating system has many benefits including: portability across the full spectrum of hardware platforms, a standard development and test platform, and an enhanced set of operating system services for supporting new embedded flight software technologies.

This investigation will focus on determining if POSIX is viable for flight software. The activities include porting an actual flight data system (MAP) to the POSIX Application Programming Interface (API), characterizing the performance impact of the port, and characterizing the practical portability of the resulting system between several POSIX operating systems.

Flight Mongoose-V Real-Time Executive for Multi-Processor Systems (RTEMS) Initiative

The Mongoose-V RTEMS initiative is a spin-off of the POSIX Flight Software Project. The near term goal is to develop a Board Support Package which meets POSIX interfaces for the free Open Source Real-Time Operating System (RTOS), RTEMS and the core flight data system derived from the Medium-Class Explorer (MIDEX) MAP data system. The ultimate goal is to fly RTEMS on Space Technology (ST-5).

Flight Linux Initiative

With the many seeming advantages to using the open source Linux operating system for flight systems, we will evaluate Linux performance on a flight platform in a heritage flight software environment.

Flight Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP) Initiative

In collaboration with Code 588, the FSW Branch has defined a prototype of the CFDP to be implemented in the 582 technologies lab and will be tested using simulated link delays. The prototype implementation will utilize the Rational Rose toolset and will be a pathfinder for the development of future flight software using Rose. The CFDP options are being defined to closely represent the intended requirements of the NGST mission.

Flight Common Object Request Broker Architecture (CORBA) Initiative

In collaboration with Code 588, we will study the usefulness of CORBA in a flight data system for implementing communications between both onboard subsystems and the spacecraft and ground controllers. CORBA provides a potential mechanism for implementing interfaces distributed across an onboard Local Area Network (LAN) without requiring explicit communications routing, buffering, and bandwidth allocation. CORBA may also prove suitable for implementing ground to spacecraft subsystem command interfaces, by providing remote access to subsystem command functions and implicit command acknowledgement.

Internet Protocol (IP) in CCSDS Initiative

The purpose of the IP in CCSDS initiative is to develop software supporting IP network connectivity in

conjunction with a traditional CCSDS flight data system. The IP tunnel can be used to demonstrate technologies relying on Internet protocols without giving up the tried and true practices of CCSDS flight data systems.

"De-CCSDS-tification" Initiative

Past flight data systems built using CCSDS standards have typically interwoven CCSDS concepts and data formats throughout the flight data system source code. The De-CCSDS-tification initiative defines a higher-level interface intended to hide the communication protocols being used by the data system, facilitating ports to newer protocols.

Highlights of Branch-internal Initiatives and Plans for the Future

Lou Hallock completed and presented the full 12 training sessions of "*Attitude Control Subsystem Concepts without an Attitude*." His series was followed by an introduction to "*Developing ACS FSW with an Attitude*", by Dave McComas. Lou and Dave hope to mature both topics and repeat the training in the future.

Mission Applications

The Mission Applications (MA) Branch provides for the development of off-line systems and applications to support Earth and space science missions. It develops operational mission data systems that include functions such as science planning and scheduling aids, guidance navigation and control software, and Network Control Center (NCC) data systems.

Management Team:

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During 2000, the MA Branch continued its software engineering support with a variety of development activities that support Goddard's mission and technology needs.

Flight Projects

After development and delivery of the Earth Observing System (EOS) Terra Flight Dynamics System (FDS) in support of the mission's December 1999 launch, the MA Branch continued sustaining engineering support until May of 2000. This support involved development and testing of software updates to incorporate new requirements and correctly identified anomalies, as well as participation on operational shifts during critical flight dynamic events.

The MA Branch supported the Imager for Magnetopause-to-Aurora Global Explorer (IMAGE) Project testing activity through the development of Science Data Pipeline functions, which ingest science telemetry data and convert it to Universal Data Format (UDF), a generic structure optimized for use with time ordered data sets. Although these Perl software scripts were later replaced by Interactive Data Language (IDL) software for operations, they were instrumental in producing necessary test files during prelaunch verification.

The FDS for Earth Observing-1 (EO-1) was developed by the MA Branch and is successfully supporting all early mission activities following the November 2000 launch. The FDS includes subsystems and utilities for attitude and orbit determination and prediction, calibration, attitude slews, momentum management, planning product generation and mission-unique science utilities.

The MA Branch also continued in its prelaunch support of the Triana and EOS Aqua missions, scheduled for launch in 2001 and 2002 respectively. For Triana, Branch personnel are developing ground data processing software for the Solar Plasma and Magnetic Field Investigation (PlasMag) instrument cluster, while Aqua support involves the development of the mission's FDS.

Mission Services

The Space Network (SN) Web Services Interface (SWSI) will provide a Java-based cross-platform customer interface for performing Tracking and Data Relay Satellite (TDRS) scheduling and real-time service monitoring and control. The development team, led by MA Branch personnel, completed design and early prototyping work, and held its Requirements/Design Review in October. SWSI is currently scheduled to become operational in early 2002.

The MA Branch also developed the Spacecraft Explorer (SE) applet/application for Goddard's Rapid Spacecraft Development Office (RSDO). This Java application provides a platform-independent tool for searching and comparing RSDO vendor spacecraft data.

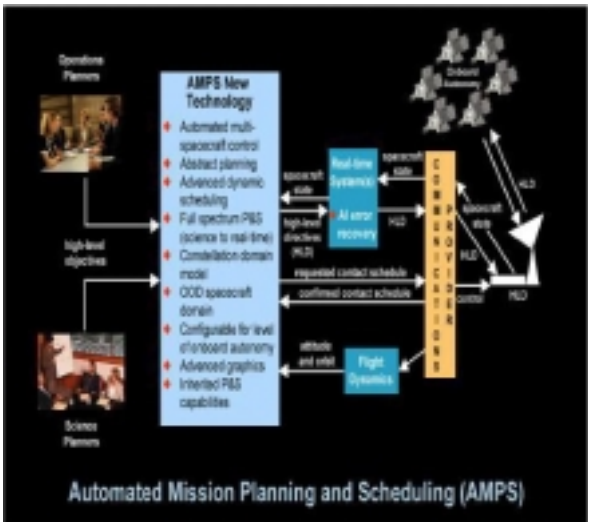
Science Community

The MA Branch provided software engineering support to the Space Physics Data Facility (SPDF) in the development of the SKTEditor tool. The SKTEditor is a Java application for creating and editing International Solar-Terrestrial Physics/ Interagency Consultative Group (ISTP/IACG) guideline compliant skeleton Common Data Format (CDF) files. This cross-platform utility will enable the science community to organize data in a standardized fashion for easier access and analysis.

As part of the Community Coordinated Modeling Center (CCMC) Team, Branch personnel developed the CCMC Web site as an interface to the space science research community. The goal of the CCMC is to both aid in and participate in the development of models for specifying and forecasting conditions in the space environment. Presently, the CCMC Web site provides information on the activity's mission, goals, and status and features several space weather models related to ionospheric, magnetospheric and solar heliospheric physics, as well as a movie of the latest Sun-Earth connection events.

Technology

In response to several Year 2000 technology proposal calls, the MA Branch developed a set of proposals that describe an innovative concept for managing constellation operations. Focusing on the theme of "*An Architecture for Constellation Management Automation*", proposals were submitted to the NASA Research Announcement (NRA) for the Advanced Cross-Enterprise Technology Development Program (CETDP) and to the Space Operations Management Office (SOMO) Technology Program.



Automated Mission Planning and Scheduling System Technology Infusion

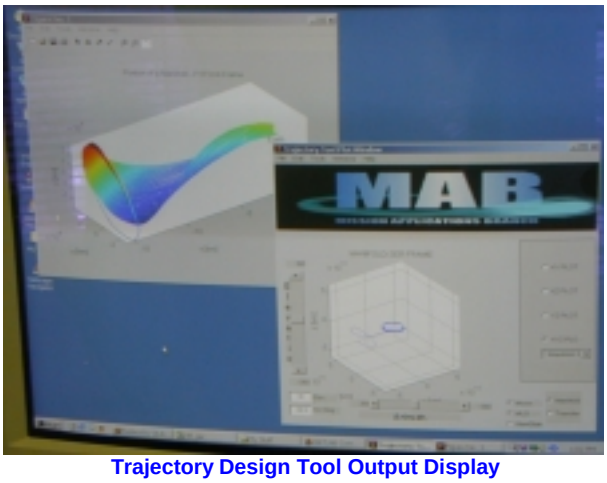
The MA Branch was selected by both programs to receive funds totaling $2M dollars over the next 3 years to develop a constellation architecture capable of

handling a variety of spacecraft autonomy levels for distributed spacecraft missions.

Guidance Navigation & Control

In support of the Guidance, Navigation and Control Center's (GNCC's) Formation Flying Testbed (FFTB), Branch personnel assumed the leadership role in Simulation and Display Software. The FFTB is a modular, hybrid, dynamic simulation facility being developed as a platform for end-to-end guidance, navigation, control analysis and design of formation flying clusters and satellite constellations. As the Simulation and Display Lead, MA Branch personnel demonstrated a variety of FFTB capabilities, including the performance of integrated analysis with existing Commercial Off-The-Shelf (COTS) tools and standalone functional components and simulators. Additional testbed verification has focused on multiple satellite real-time relative navigation simulation, closed loop control analysis and dissemination of real-time displays of simulated satellites through the Internet.

The Trajectory Design Tool (TDT) was developed by the MA Branch to assist flight dynamics analysts in planning transfer trajectories, such as those from Earth orbit to a libration point. Developed in the Mission Applications Technology Lab (MATLAB), the tool eliminates the reliance on an iterative guess-and-analyze process, reducing trajectory design time in some cases from days to less than an hour. Flight dynamics analysts are using the TDT in support of the Triana mission.



Trajectory Design Tool Output Display

Software Engineering

As a result of their recognized software engineering expertise, MA Branch personnel provided general software process support to various GSFC and NASA-wide activities. The MA Branch was instrumental in the development of the draft Goddard Procedure and Guideline for Development and Maintenance of Software Products (GPG 8700.5), and provided internal auditor support to GSFC organizations and the NASA Independent Verification and Validation (IV&V) Facility as part of NASA's ISO 9000 activities. The MA Branch provides GSFC membership in the NASA Software Working Group, and provides support to the ISC Software Engineering Laboratory (SEL).

The Real-Time Software Engineering (RTSE) Branch develops ground data systems for integration and test and on-orbit operations of Earth and space science missions.

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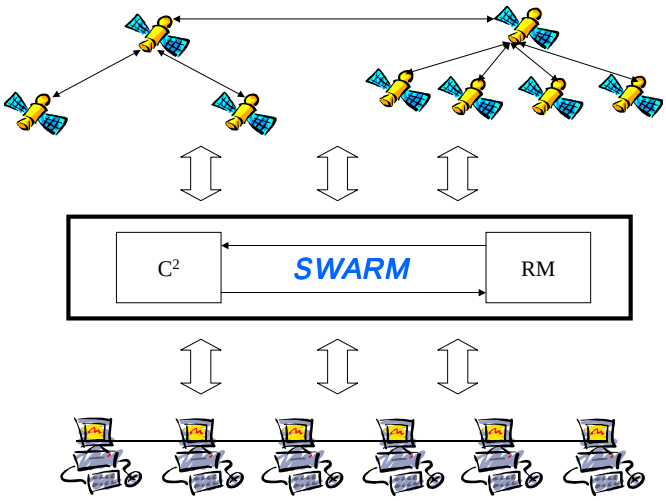
Wearable Voice-Activated Computers (WEVAC)

584 Summer Student Danny Green with first WEVAC Prototype.

Members of the RTSE Branch, including two college summer students and a Cooperative Education Program (CO-OP) student, developed a pair of wearable, wireless, voice-activated computer integrating off-the-shelf software and hardware components. Audiences were impressed by the show-and-tell presentations provided by the students. The prototype demonstrated wireless communications and voice recognition technologies. We evaluated several speech recognition and collaboration software packages and researched the latest in lightweight and portable microphones, computer central processing units (CPUs), cameras and head mounted displays. While writing funding proposals, we considered a wide range of NASA crosscutting space applications that would benefit from having instant Internet, network and computer access with complete mobility and hands-free operations. These applications include spacecraft fabrication, integration and testing, and astronaut on-orbit control and monitoring of experiments with ground based experimenters.

Sensor Web Adaptive Resource Management (SWARM)



With Ohio University, Code 584 won a 2-year joint proposal to the Earth Science Advanced Information Systems

Technology Program. The goal is to evolve the Defense Advanced Research Projects Agency (DARPA)-funded DeSiDeRaTa adaptive resource approach to a sensor Web. The approach uses middleware to adapt resource allocations and a framework to reason with Quality of Service objectives about real-time performance of distributed application systems. The effectiveness of adaptive resource management will be demonstrated in a Goddard-developed, ground-based real-time system called Integrated Test and Operations System (ITOS). At the end of the year, we won funding for a second effort with Ohio University to prototype real-time resource management using real-time adaptive agents.

Real-Time Software Engineering Lab

The Real-Time Software Engineering Lab continues to evolve. Current projects in the Lab include: Triana, Integration and Test (I&T), Rapid Application Development (RAD) Lab, WEVAC, Mission Operations Center (MOC) Technology Exploration and

Development Space Operations Directive Agreement (SODA) Task, Simulators Center of Excellence, Operating Missions as Nodes on the Internet (OMNI), Nexus Product Evaluation Team, and WIND/POLAR/SOHO Software Maintenance.

AETD Career Mentoring Program

Code 584 continued to develop and coordinate the AETD Minority Career Mentoring Program (MCMP) as it completed a successful first year and began a second. The program has been well received by AETD management and the results of the program thus far have been very positive. Branch members host information sessions and training classes for mentors and protégés and maintain the program's Web site with up-to-date information.

Earth Science Data and Information Systems (ESDIS)

Code 584 continues to support the Earth Observing System (EOS) PM/Aqua, Chemistry Mission (CHEM)/Aura mission, and Ice, Clouds, and Land Elevation Satellite (ICESat) in the roles of Control Center management and Earth Observing System Mission Operations System (EMOS) Integration and Test Manager.

EO-1 Launch, Nov 2000

Earth Orbiter-1 (EO-1)

Code 584 supported the successful control center and mission operations preparations for the EO-1 launch in November 2000.

Advanced System for Integration and Spacecraft Test (ASIST) Development Team

The ASIST Team supported a number of missions and instruments including Geoscience Laser Altimeter System (GLAS), Tropical Rainfall Measuring Mission (TRMM), EO-1, Microwave Anisotropy Probe (MAP), Imager for Magnetopause-to-Aurora Global Explorer (IMAGE), Space Technology-5 (ST-5), Nexus in I&T and preparing for operations. The ASIST Consultative Committee for Space Data Systems (CCSDS) Ground Telecommanding software continues to be used for I&T and (pre-launch) Control Center operations of the EO-1, IMAGE, and MAP spacecraft, as well as several instruments in development. Code 584 continued to support other on-going missions with system administration support, supported ground system formulation for the ST-5 Mission (which has chosen ASIST for I&T and mission operations), and set up evaluation demos for Nexus. They continued to support the international CCSDS standards at meetings and conferences.

Image satellite, Pre-launch

Space Operations Management Office (SOMO)/ Consolidated Space Operations Contract (CSOC)

Code 584 continued to support SOMO/CSOC efforts, serving on the Front End Processor (FEP) Consolidation Vertical Integration Team, and supporting Space Network customers in network operations and planning including Earth Radiation Budget Satellite (ERBS), TRMM, Upper Atmosphere Research Satellite (UARS), Land Remote Sensing Satellite (Landsat-7), Compton Gamma-Ray Observatory (CGRO) (and the CGRO deboost), pro Small Expendable Deployer System (SEDS), and Hubble Space Telescope (HST). Code 584 also continued to manage two CSOC SODA Tasks, the Simulators task and the MOC Technology Development Task. The Simulators task delivered their Scaleable Integrated Modular Simulation Suite (SIMSS) to Aqua and EO-1 this year. The team also evaluated and developed a simulator prototype using the Department of Defense (DOD)/Institute for Electrical and Electronic Engineers (IEEE) standard "High Level Architecture" (HLA) that allows for distributed simulations across a wide area network. The MOC Technology Development and Exploration Task implemented a task-developed product, named Jswitch into X-Ray Timinig Explorer (XTE) operations for secure, remote access to engineering data and events in near real-time. The task also began investigating technologies, such as Biometric authentication that can be applied to secure mission operations.

HST

The HST continued to operate nominally after the re-servicing mission 3A, and plans continued for servicing mission 3B. Code 584 supported the project in a variety of roles including lead Control Center Systems (CCS) Systems Engineer, CCS Developers, Operations Configuration, International Standards Organization (ISO) Compliance Manager, and Instrument Lab Programmer.

Nexus/ Next Generation Space Telescope (NGST)

Code 584 supported the Nexus and NGST in the compilation of cost estimates for the ground system and simulation systems, and a detailed evaluation of available existing Commercial Off-The-Shelf (COTS) or Government Off-The-Shelf (GOTS) ground systems.

Science Visualization Lab

Code 584 continued to support the Science Visualization Lab, which included the development of animations of Greenland ice density. These animations were used in a July 20th Press Release, the Aug. 7 issue of Space Ops, and appeared on CNN and MSNBC. Web pages were developed showing images of the Mozambique floods (shown on CBS and ABC evening news), Mars Orbiter Laser Altimeter (MOLA), Significant Artic Ozone Loss, and TRMM/Geostationary Operational Environmental Satellite (GOES) Data, which is used to improve hurricane predictions.

Hitchhiker

The Hitchhiker Development Group completed the design of the next generation Hitchhiker Control Unit and began development for the next generation avionics system to support upcoming Hitchhiker programs and missions. The team is also supporting some new Hitchhiker-related projects such as Expedited Processing of Experiments for Space Station (EXPRESS) Palet Adapter Module (EPAM). EPAM is a new flight avionics design intended to provide Hitchhiker-like service to small payloads flying on the International Space Station (ISS). The team is also preparing for the STS-105 launch in June 2001. This launch will be supported by the new Hitchhiker design. The team is also supporting the Triana mission as part of the Triana Airborne Support Electronics. The next Hitchhiker mission is scheduled for March 2001. Acceptance testing for the new design began in September.

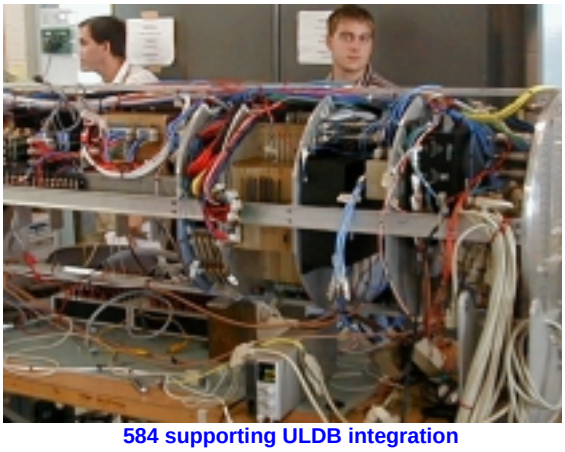
584 supporting ACE thermal vacuum testing, November 2000

Triana

The Integrated Test and Operations System (ITOS) Group continued to support Triana I&T including supplying the Data Trending and Analysis System (DTAS) for Triana.

Ultra Long Duration Balloon (ULDB)

The year 2000 was characterized by much success and visibility for 584 at Wallops. Major deliveries for the year included flight software and ground control center systems for NASA's ULDB Project. Slated to fly a space science mission in 2001, the ULDB is a next generation balloon capable of staying aloft for up to 100 days. The flight software was developed in-house and is designed to be highly reusable from mission to mission. The new control center systems are based on existing GOTS software that were extended and tailored for balloon-specific use.



584 supporting ULDB integration

NASA Tracking Station Support

Code 584 also provided support for standard on-orbit missions. The final transition of automated tracking sites at Wallops, Fairbanks, AK and Svalbard, Norway was completed this year. These sites support the Space Operations Control Board (SOCB) Mission set and the completion of their automation software marks a milestone in their ability to support more missions at a lower cost to NASA and its customers. As a part of the automation, 584 completed work on the Standard Autonomous File Server (SAFS), an automated data delivery and archive system that allows confirmed delivery of spacecraft science data products directly to the science user's desktop or processing system.

Advanced Earth Observing Satellite 2 (ADEOS2)

Support for on-orbit science missions was not confined strictly to NASA missions, however. ADEOS2, a joint NASA/National Space Development Agency of Japan (NASDA)/National Oceanic and Atmospheric Administration (NOAA) mission, is also counting on 584 for ground implementation. Code 584 personnel traveled to Japan to work with NASDA scientists and engineers to manage implementation and testing of flight to ground interfaces and operations concepts for this mission.

ADEOS-2 Mission Operations Meeting #7, held in Alaska in June 2000

Advanced Range Technology Initiative (ARTI)

Technology development also played a large role in the activities of Code 584. One major technology thrust is in the area of ARTI. ARTI is an effort to focus on technology challenges that will benefit spaceport, launch range, and range safety functions performed by

NASA at numerous sites and Centers. One effort in particular showed much promise – the Flight Modem. Initiated as a GSFC Internal Research and Development (IRAD) activity, the Flight Modem will allow two-way Internet Protocol (IP) based data transfer between an in-flight launch vehicle and a launch control center using no ground infrastructure. Initial tests of the technologies involved a prototype system developed by 584 at the Wallops campus, which were flown on aircraft and balloons over the Western United States and off the coast of Florida. The success of these early tests led to a proposed test aboard a Sounding Rocket to be conducted in January of 2001. Other ARTI-related efforts have focused on Launch Safety Knowledge Engineering efforts, Autonomous Flight Termination Systems, and air and sea surveillance systems.

Flight Modem Front Panel

Proposals

Steve Bailey recently submitted a winning proposal to the GSFC IRAD proposal call titled, "Flight Hardware Methods for Ocean Color Inversion."

Karen Keadle-Calvert and Sharon Orsborne won funding for their Commercial Technology Development proposal, "A Multi-function PCI Digital Data Board for Spacecraft Communications."

John Donohue's proposal titled, " Risk Analysis for Operating Spacecraft as Internet Nodes" was funded by SOMO for FY01.

Tim Ray was awarded funds from SOMO after submitting his winning proposal on CCSDS File Delivery Protocol (CFDP), which is a file transfer protocol that can run directly over CCSDS Telecommand links.

Barb Pfarr (GSFC Co-Principal Investigator (Co-PI)), Dr. Lonnie Welch (Ohio University Principal Investigator (PI)) and Dr. Brett Tjaden (Ohio University Co-PI) authored a winning proposal titled, "Adaptive Resource Management for Distributed Real-Time Systems." Code 584 is teaming with Ohio University in accomplishing the work defined in the proposal. Ryan Detter (GSFC Cooperative Education Program (Co-Op)) supports this work at GSFC using ITOS as the prototype system. Ryan is supporting this work, which involves integrating the ITOS system with Ohio's algorithms for real-time resource management of distributed systems without timing constraints.

The Computing Environments and Technology (CET) Branch provides infrastructure support to scientific, project, administrative and outreach activities across the GSFC.

Management Team:

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Overall, Code 585 had a productive year in 2000. Our staff was engaged in numerous leadership activities and technical projects that support the ISC, GSFC and NASA. The majority of these activities focused on our primary strengths, Information and Knowledge Management, Information Technology (IT) Security, and Networking and Communications. Representative of our involvement in Information and Knowledge Management was our work on the Agency Knowledge Management Team, the completion of a multi-center NASA Chief Information Officer (CIO) pilot proposal titled "Expert Directory Service", Resume Management and the Brio Pilot supporting the Integrated Financial Management Program (IFMP), and our work on the Agency Accessibility Team. For IT Security a NASA CIO pilot proposal was awarded to facilitate "remote control of vulnerability scanning devices." For Networking and Communications, our team supported the Global Legal Information Network (GLIN) demo and the Internet2 initiative.

Knowledge Management (KM)

Steve Naus of Code 585 represented GSFC on the Agency-wide KM Team developing a draft strategic plan and road map for KM initiatives within NASA. Accomplishments during CY00 included documenting NASA's "Best Practices" in KM and researching industry and external to NASA best practices in KM. During the CY99 NASA CIO Agency-wide IT Pilot Proposal call, Steve Naus' proposal "Expert Directory Service" was accepted and funded. This proposal was one component in the Federated KM Architecture Prototype Project with the Jet Propulsion Laboratory (JPL) and Langley Research Center (LaRC). Code 585 collaborated with the Goddard Earth Sciences and Technology (GEST) Center/Code 930, Florida International University (FIU) and University of Maryland Baltimore County (UMBC) to investigate advanced Web-based technologies. The major accomplishment during CY00 was that standards, processes and tools for the capture, retention and dissemination of information that establishes the foundation of an expertise/project-based directory service were piloted.

Code 585 investigated various commercial offerings in knowledge portal technology, selecting Autonomy's knowledge server and update to provide Web mining capabilities and KM solutions. The information captured through Autonomy will become the foundation of knowledge that could be used in next generation Intranet for the Center.

Code 585 performed an in-depth internal study of the ISC's current knowledge environment to aid in developing a knowledge environment roadmap. Knowledge gained from this study was critical in establishing requirements for selecting the knowledge portal solution identified above.

IFMP

Code 585 has provided system engineering support to the IFMP Office/ Code 400.2 at GSFC for the past several years. During CY00 there was a major change in focus in the IFM Program directed by NASA Headquarters and the 585 support provided was reduced to meet the redefined need. The two technical areas that Code 585 became responsible for were establishing an Agency-wide Resume Management system led by Tom Weber and accessing the Agency's Financial and Contractual System (FACS) data through a Brio environment led by Debbie Sharpe, as a pathfinder activity for the IFM reporting environment.

For the Resume Management activity, accomplishments include:

- establishing the Agency's requirements for this capability
- developing the statement of work (SOW), releasing a Request for Proposal (RFP), evaluating proposals, and selecting a Commercial Off-The-Shelf (COTS) product (Resumix)
- establishing the Agency's requirements and schedule for implementation as well as developing the SOW for the implementation RFP

During CY01, the Resume Management system will be implemented across the Agency.

For accessing the Agency's FACS data through a Brio environment, accomplishments include:

- establishing the Agency's requirements, system architecture, and data warehouse design for this capability
- conducting a design review with Agency participation
- installing the Prototype S/W at Marshall Space Flight Center (MSFC) (the IFM Integration Center)
- providing training for individuals to be performing usability testing
- conducting usability testing
- Presenting status, plans, and a demonstration to the Agency financial community as a prerequisite to rollout

During CY01, the Brio environment for accessing Agency FACS data will be rolled out to each NASA Center for use and evaluation and all end users will be trained.

Accessibility

In June 2000, Lee Holcomb, NASA CIO, nominated Tom Weber of Code 585 to represent NASA as the Section 508 IT coordinator on the government-wide Federal IT Accessibility Initiative. Tom reports status and progress directly to the NASA CIO while he chairs a team of representatives from across the NASA Centers. Section 508 is a part of the Rehabilitation Act of 1973, which requires that electronic and information technology developed, procured, maintained or used by the Federal government be accessible to people with disabilities.

There were three major accomplishments during CY00. The first accomplishment was to ensure that the top 20 NASA Web-sites were made accessible. The second accomplishment was to ensure that the Federal IT Accessibility Initiative proposed standard was reviewed and commented on by NASA. The third accomplishment was to ensure that a set of Web development guidelines was produced with the goal of assisting Webmasters in making all NASA Web sites accessible to persons with disabilities.

In CY01 it is anticipated there would be, under Tom's direction, a significant effort to educate the GSFC Webmasters community and other IT areas about Section 508 and their responsibilities to ensure compliance.

IT Security

During the CY00 NASA CIO Agency-wide IT Pilot Proposal call, Dick Schneider's proposal "Remote Control of Vulnerability Scanning Devices Pilot" was accepted and funded. Because there is now an Agency requirement that each NASA Center perform vulnerability scans each quarter on all computers, this proposal provides an opportunity to investigate an important aspect of IT security at GSFC that could be applied to other NASA Centers. Currently it is very time and labor consuming to "scan" an entire Center's computers. It has been recognized that there must be better, more automated means of vulnerability scanning and associated data collection and vulnerability report dissemination. The proposed solution to this problem is the implementation of a remote control scanning system that would provide a capability to centrally control the scanning process. The accomplishments of this proposal will enable both the manual and automated control of in situ subnet/supernet vulnerability scanning devices running a specific COTS software scanning product.

The major accomplishment during CY00 was the development of more robust reporting to enhance the information value to management. Currently, the COTS tool has limited high-level reporting capability and this enhancement provides management a clearer snap shot of network regions of IT security concern.

During CY01, the full remote control of vulnerability scanning devices pilot will be implemented and checked out at GSFC.

GLIN Demo

Code 585 provided network-engineering expertise in support of the satellite communications demonstration for GLIN held on September 6, 2000 at GSFC. This international program successfully utilized PanAmSat's Galaxy satellite, two terminals and modulation and coding equipment as well as terrestrial links and the computer hardware and software. The audience, which included representatives from NASA, the National Institute of Health's (NIH's) National Library of Medicine (NLM), the Library of Congress, and twelve foreign countries were impressed with the potential of satellite communications to serve effectively in a global digital library network. The demonstration consisted of remotely (over the satellite link) accessing an Oracle database (GLIN) and video conferencing using Netmeeting. The two members of

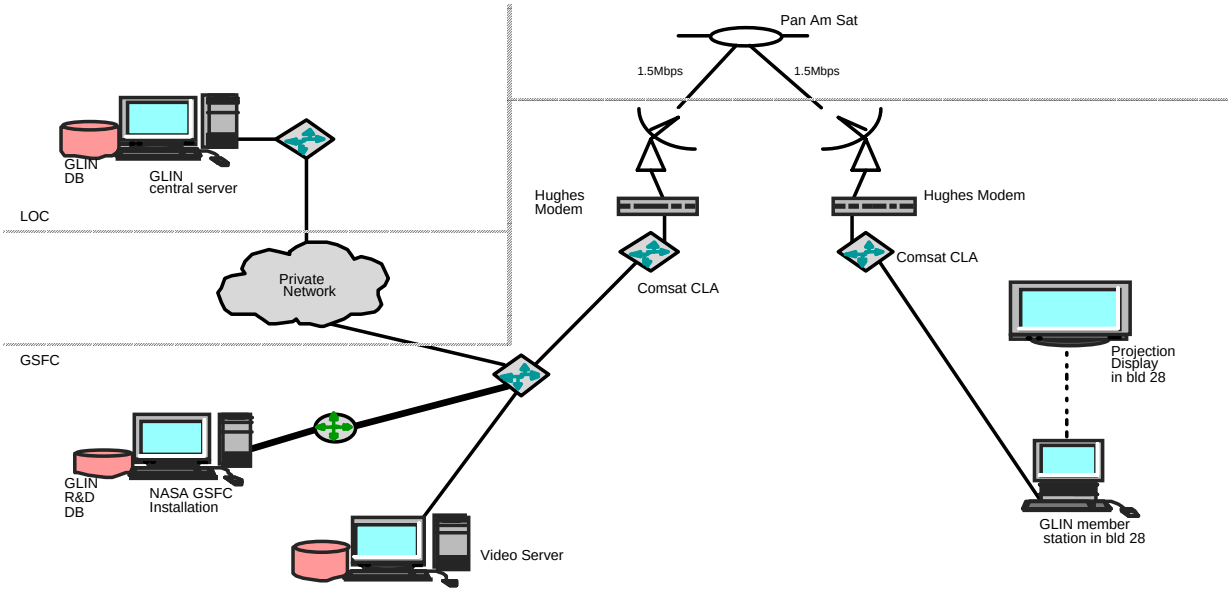
Code 585 who played a significant role in the activity were Kevin Kranacs and Freemon Johnson. Kevin was the overall technical configuration and operations leader for the entire demonstration. Kevin oversaw the application demo's planning, arranged nominal satellite time schedules with PanAmSat prior to and during the demo, and enabled the first end-to-end setup and check out of all the GSFC-based equipment. Freemon performed technical configuration and setup of the Comsat Internet Protocol (IP) router, assisted in conducting end-to-end check out of the ground system configuration, and performed pre-demo end-to-end performance testing of the applications.

Dr. Rubens Medina, Law Librarian and Director General of GLIN, wrote a letter to GSFC acknowledging all the arrangements that were made for the demonstration. He cited that "the demonstrations given by you and members of your staff utilizing the live satellite connections were extraordinary, and vividly conveyed the advantages that this technology promises for GLIN members." Below is a diagram of the GLIN architecture.

Internet2 Initiative:

Code 585 provided network engineering to the Earth Science Data and Information System (ESDIS) Project at GSFC. A significant focus of this support during CY00 was to more cost effectively transfer data at higher rates to the NASA funded scientists and researchers. Over 200 Earth Observing System (EOS) researchers are at universities that are members of the University Corporation for Advance Internet Development (UCAID), and are connected to the Abilene Network. NASA and UCAID researchers are also participating in developing the network technologies of the future. Recognizing the commonality of goals between the entities, Jeff Smith of Code 585 facilitated the membership of the Earth Observing System Data and Information System (EOSDIS) in the UCAID organization to collaborate on the development of these network

LOC - NASA GSFC
GLIN Demo Setup



technologies. He further worked to connect GSFC to the Abilene Network, getting "dark Fiber" installed from GSFC to University of Maryland College Park (UMCP) and joining the Mid-Atlantic Crossroads (MAX) located at UMCP. This high speed connection has provided GSFC with extremely cost effective network connectivity to its university partners.

Thrusts for CY01

Code 585 will continue to focus on its three primary skill areas during this next calendar year: Information and KM, IT security, and Networking and Communications. Representative examples of activities in these areas are noted below.

Information and KM

During CY01 a pilot will be established to define an organization's knowledge environment. That is, a clear picture of what information they have, what they will need and what is of little value will be obtained. Then knowledge maps to the organization's core competencies that will organize information for the workforce will be created. Further structure for the effective development, recognition, retrieval, and contribution of knowledge will be provided. Finally the organization's key business process information will be improved thus making processes more effective.

As part of a knowledge environment pilot, a new Centerwide Intranet is under study for deployment, helping organizations improve performance through better information management. Not only will employees be able to find information faster and easier than ever, they will have the capability of customizing their user interface through agents to meet their specific knowledge needs. Based on these agents, the Intranet will provide communities of practice, bringing together employees who have similar interests. Additionally, the Intranet will provide improved IT security through a single sign-on feature and encrypted transmissions using secured socket layer (SSL), allowing the employee to focus on the task at hand. Code 585 will collaborate with GSFC's Library Information Services Branch (Code 293) in the use of advanced Web-based mining tools to demonstrate the capture, retention and re-use of GSFC project data, specifications and documentation that historically has been archived and unavailable for future use. As part of this collaborative effort, emerging portal technology and how the latest developments will best benefit the capture and re-use of information will be investigated.

IT Security

In CY01, an effort to improve the ISC IT security posture against threats and vulnerabilities will be initiated. Because of the threat of computer hacking, intrusion and disruption continue to be a severe risk to ISC development activities. Code 585 will initiate activities intended to limit the impact of inappropriate attacks on government resources. Specifically, we will improve upon our ability to withstand illegal intrusions as well as how we respond to them. Our approach centers around education for our user and system administrator communities, keeping current with vendor security patches, and sound policies and procedures for system administrators prior to connecting systems to the GSFC network. In addition, we will establish

routine and on-demand scanning of systems for security vulnerabilities, and we will investigate intrusion detection systems for applicability to our environment.

Another thrust for us will be to propose an investigation into a single sign-on authentication application to the NASA CIO Pilot Proposals call. We propose to investigate and pilot standard authentication infrastructure tools that allow one time authentication from central and remote locations using traditional and biometric methods, ensure secure storage of user credentials and easy integration with existing Public Key Infrastructure (PKI) technologies, and have minimal impact on NASA's network resources. A simple single sign-on application, located on an independent server, will meet this challenge by acting as a sentry between the users and the participating applications.

Networking and Communications

Through the Commercial Technology Office (CTO), GSFC is supporting a business incubator activity, the Emerging Technology Center (ETC), located in The American Can Company building in Canton, MD (close to Baltimore's Inner Harbor). Code 585 network engineers will provide high-speed network access from GSFC to the ETC. We will lead the coordination of delivery of most of the items necessary for network connectivity to the ETC, as well as acting as a point of contact for network connectivity issues on the network link. The planned design of this link is to go through the University of Maryland Network System from UMBC to UMCP and then from UMCP to GSFC over an existing connection. In the future, the connection is expected to go over Maryland State fibers.

The Science Data Systems (SDS) Branch supports the Earth and space science communities by providing a wide range of data systems solutions in response to technical requirements.

Management Team:

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During 2000, the SDS Branch continued to support the Earth and space science communities at GSFC by developing systems for science data capture, level-zero and higher-level data processing, data archival, data distribution, and information management. Branch members and supporting contractors were involved in numerous activities responding to the priority needs of existing customers, as well as activities to establish new customers and to advance the leading edge of technologies needed to better perform these functions. The pace for the year was set by several major flight milestones: the launch of Terra in late 1999, the Hubble Space Telescope (HST) servicing mission 3A in late 1999, the launch of Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) in March 2000, as well as Y2K.

The Branch strives for recognition of its ability to appropriately utilize the latest technologies, existing Commercial Off-The-Shelf (COTS)/Government Off-The-Shelf (GOTS) products, cost-saving strategies, and current design and development methodologies. It hopes to establish its reputation for providing high-quality products: studies, consulting, prototyping, design, development, verification, and sustaining engineering. It attempts to do this in a way that is rewarding, challenging, and interesting for its members. We recognize these as essential ingredients in building a diverse, talented, innovative, energized, internationally recognized workforce of employees and managers.

In addition to delivering high-value products and services for ongoing projects, the SDS Branch is planning for future challenges in support of new, exciting NASA projects and missions. As the priorities of our current customers evolve and as we plan for a shift toward full-cost accounting, we realize the Branch may have to compete for much of its future work. This will necessitate careful nurturing of the core competencies of the Branch and an increase in the number of internal projects funded by proposals. We hope to establish a market for the Branch's capabilities. To be successful we will continue to maintain open, flexible, collaborative working relationships with customers and other partners.

Science Data Systems

Project, Laboratory, and Institutional Support

Branch members matrixed to projects, science laboratories, and institutional groups led the development of systems providing various levels of science and ancillary data processing starting from the point of the data reaching the ground until they are delivered to scientists or scientific data users for analysis. The systems ranged in complexity. At one end were those that handle single, small instrument data streams with a limited user community such as the Low Energy Neutral Atom (LENA), an instrument on IMAGE. At the other end were the large multi-mission, distributed data systems serving diverse multi-disciplinary user communities such as the Earth Observing System Data and Information System (EOSDIS) which supports Terra data management.

Some of the major contributions to these groups follow:

HST

The SDS Branch supported the HST servicing mission by managing response to anomalies, verifying mission orbits, and standing by to ensure Y2K transition. A Branch member also played a major role in the successful transfer of HST operations to the Space Telescope Science Institute (STScI). Other Branch members provided on-going sustaining engineering for the Vision 2000 Control Center System.

IMAGE/ Microwave Anisotropy Probe (MAP)

The Branch provided ground systems communications support for these spacecraft. Another Branch member provided on-going sustaining engineering for the IMAGE Level-Zero Product Generation System during testing and early launch in order to ensure adequate performance.

Tropical Rainfall Measuring Mission (TRMM) Science Data and Information System (TSDIS)

The SDS Branch supported the development of Science Processor (SciPro), a flexible, portable system that processes raw science data in a serial fashion.

National Polar-Orbiting Environmental Satellite System (NPOESS) Preparatory Project (NPP)

The Branch played key roles during mission formulation and definition leading the development and acquisition efforts for the science data segment and also instrument accommodations. These efforts led to a successful Mission Systems Requirements Review. This project presents new challenges with its interfaces with National Oceanic and Atmospheric Administration (NOAA) and Department of Defense (DOD) and utilization of high-performance instruments.

Solar Terrestrial Relations Observatory (STEREO)

The Branch provided software systems engineering support and participated in a Ground Systems Requirements Review.

Earth Science Data and Information System (ESDIS)

Much of the focus early in 2000 was in preparing to open the doors for public access to Terra data slated for mid-April. The SDS Branch supported science operations, development of

various releases of the science data processing system, enhancement of information management capabilities, enhancement of the performance of level-zero processing, integration and testing. Personnel also continued planning for the upcoming Aqua mission by establishing interfaces with instrument teams, planning for storage and distribution of data, acquiring hardware, and performing operational simulations and other tests. The Branch was involved in the successful Modified Antarctic Mapping Mission. Branch members interacted with the user community through participation in organizations such as the Earth Science Enterprise Federation (chairing various sub-committees) and user working groups. They also hosted seminars and workshops to train users in the use of tools for search, order, visualization, and manipulation of data and to define requirements for Application Program Interfaces to the Earth Observing System (EOS) Clearing House (ECHO). They addressed various issues such as billing and accounting and long-term archive by conducting various prototypes.

LENA

The Branch supported the LENA Science Team by developing image processing software, implementing science algorithms for monitoring the Earth, Sun, perigee and apogee, and developing a Web site to make the data and information easily accessible. Support was required for quick image quality assessment and data analysis during early instrument check out and receipt of first light images.

Triana

The Branch developed alternate options for a Triana Science Operations Center (SOC) and managed ground system implementation. These efforts were reviewed by an independent science review board and in various requirements, system design, critical design peer, and pre-ship reviews.

Laboratory for High Energy Astrophysics (LHEA)

The Branch developed and maintained various Web pages (for example Microwell Project), supported Y2K conversion efforts, received and processed instrument data sets (such as Transient Gamma-Ray Spectrometer (TGRS) and Konus).

Space Operations Management Office (SOMO)

The Branch supported standards efforts, administration and oversight of the Consolidated Space Operations Contract (CSOC) and various CSOC design and technology reviews. The standards efforts included on-going support for various Consultative Committee for Space Data Systems (CCSDS) panels (1a, f, 2, 3) as well as managing a new effort for space link protocol testing using the Science and Technology Research Vehicle (STRV).

National Space Science Data Center (NSSDC)

The Branch led the development of a Java version of NSSDC's Common Data Format (CDF) tools and the conversion of documentation to a more easily maintained form.

Spacecraft Emergency Response System (SERS)

The Branch helped to transition this system from a research project into a commercialized product by instituting configuration management and change control and producing user and programmer documentation.

Integrated Mission Design Center (IMDC)

The Branch provided science data systems engineering support for planning future missions such as Living with a Star Ionospheric Mapper Missions (IMM) and Inner Heliospheric Sentinels and Global Precipitation Mission (GPM).

Earth Science Technology Office (ESTO)

The Branch supports the management of winning proposals under the Agency of Industrial Science and Technology (AIST) NASA Research Announcement (NRA).

SDS Branch Products and Services

In addition to specific systems work, the Branch pushed the leading edge of information system technology and explored new information technologies. During 2000, Branch members participated in the development of prototypes involving new techniques for data display, data packaging, and development of reusable software libraries designed for the science community. They also responded to various calls for proposals to improve information management and assisting in planning the future vision for the Earth Science Enterprise. Several Branch members were successful with their Independent Research and Development (IR&D) proposals and a Director's Discretionary Fund (DDF) Proposal.

Many of these activities were supported by the QSS Group, Inc., under the Multidisciplinary Engineering Development Services (MEDS) Contract, and CommerceOne under various General Services Administration (GSA) Indefinite Delivery-Indefinite Quantity (IDIQ) contracts.

Science Data Processing Workshop 2000

The Branch, in conjunction with the Advanced Data Management and Analysis Branch (Code 587) and scientists in the Laboratory for Extraterrestrial Physics (Code 690), hosted a successful Science Data Processing Workshop at GSFC. Over 170 software programmers/engineers, data system managers, project managers, and scientists attended case study presentations, poster sessions, tools and techniques sessions, and participated in splinter sessions to develop ideas for improving science data processing.

Recommendations and next steps were developed by the splinter groups. A recurring next step from the splinters was to repeat the conference annually, and expanding participation to all NASA Centers. This theme was repeated in the evaluations received. Other common themes for next steps included obtaining funding to develop toolkits and testbeds and a knowledge base for sharing information.

This first workshop was targeted to Goddard. Over half of the registrants were Goddard employees, while the rest

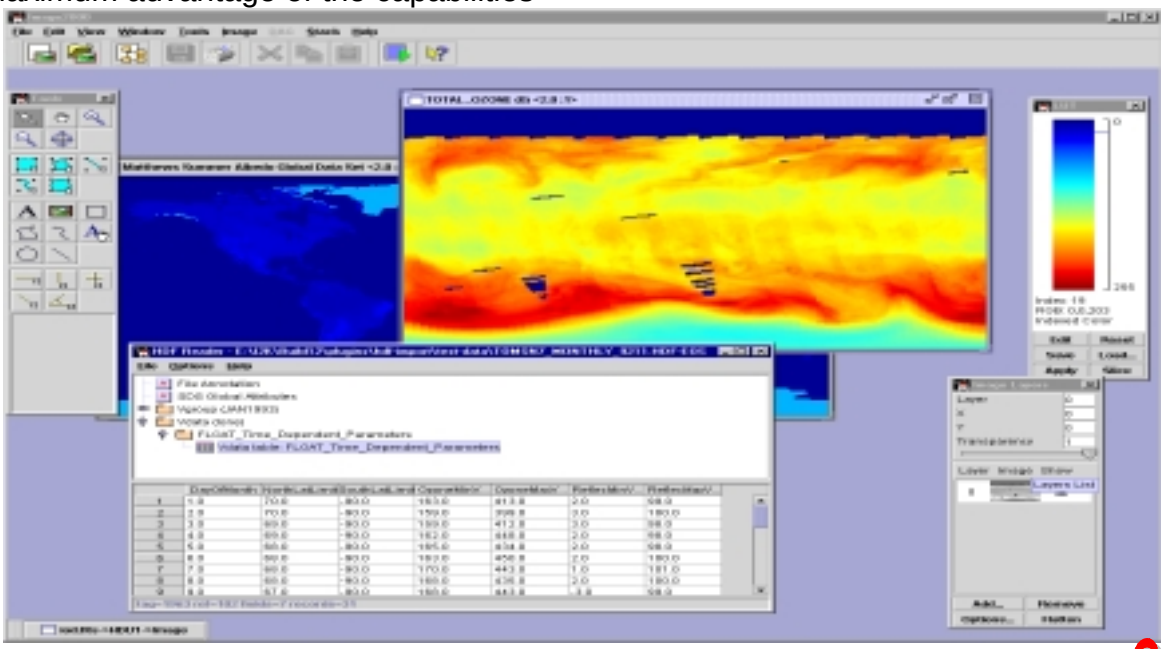
were contractors supporting GSFC projects—although there were a few from other NASA Centers and other contract organizations. Over one-third of the attendees were affiliated with Code 500, one-third from Code 900, one-sixth from Code 600, and the rest from Codes 100, 400, and 700. The workshop allowed these scientists and system developers to share tools, ideas, and data processing methodologies that form a common thread across disciplines, projects, missions, and instruments.

Mission Survey Database

The Branch developed a tool that allows perusal and capture of mission characteristics with a standard browser. Users can downlink data rates, access data volume, mission sponsors and mission Web site links, and determine the location of processed data sets. Developers can use this tool to identify commonality between existing missions and new missions, such as during planning sessions at the Integrated Mission Design Center (IMDC). This allows us to ensure that whenever possible and practical, we take maximum advantage of the capabilities and/or inherent design features of existing, field-proven, and comparably-scaled ground systems, thereby reducing development costs.

Science Data Processing Tutorial

In September 2000, the Branch released a Web-based, interactive Science Data Processing Tutorial http://that.gsfc.nasa.gov/gss/tutorials/gsdp/index.html that provides a detailed introduction to the functions necessary to capture real-time data from a typical NASA remote-sensing observing platform and perform all functions performed by the ground system. The goals of this effort were to help reduce the learning curve for new employees involved in science data processing, educate existing and potential customers to the technical issues associated with ground systems, and provide information to educate the general public. Topics covered by the tutorial include an overview of the mission of the Branch, a description of the key elements of the communication infrastructure, the use of ground antennae, techniques of signal



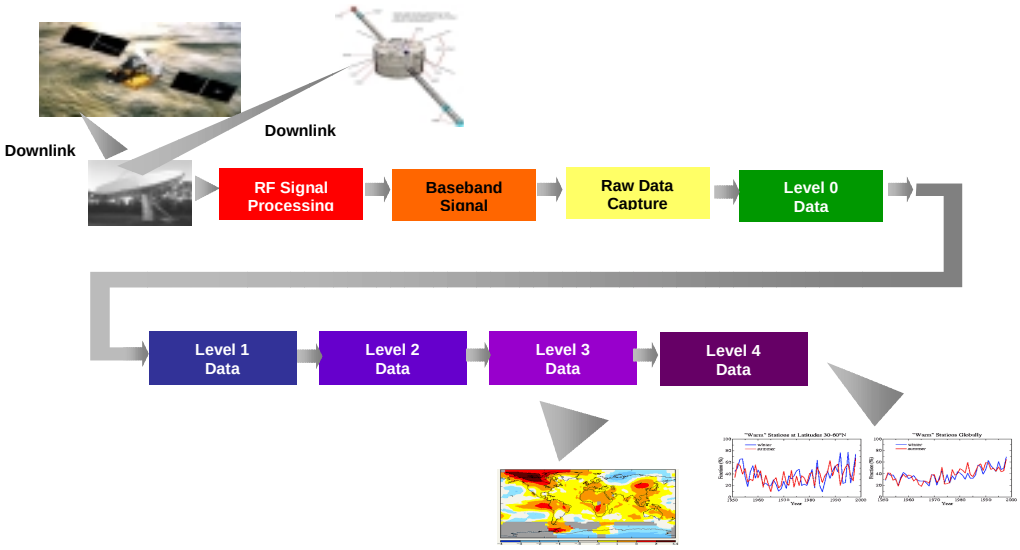
processing, and a description of the steps necessary for calculation of the science products. The tutorial is designed to be user-friendly, with the topics organized clearly and the various modules displayed with Macromedia Flash Player animations.

With the anticipation of additional staffing in 2001, we expect the tutorial to be especially useful for new employees hired directly out of college. Typically such persons are degreed in Computer Science or Software Engineering and would not have strong backgrounds in science data processing. The tutorial provides a broad overview of a mission along with necessary details. For example, in describing the ground system functionality the tutorial uses the Terra satellite and its payload as an illustration to explain basic terminology such as multiplexing, modulation, and telemetry. Aspects of baseband processing are also discussed in appropriate detail, including the bit synchronization, Viterbi decoding, frame synchronization, CRC checking, and the Reed-Solomon decoding steps.

During 2000, the Branch also released three Web-based tutorials to assist and support programmers in the development of applications to read and write science data using state-of-the-art formats. These tutorials address some of the salient characteristics of the more commonly used data formats that are produced by remote sensing ground processing systems in support of the Earth, space, and planetary sciences. Included are tutorials for the Hierarchical Data Format (HDF) http://that.gsfc.nasa.gov/gss/tutorials/hdf Common Data Format (CDF) http://that.gsfc.nasa.gov/gss/tutorials/cdf Flexible Image Transport System (FITS), http://that.gsfc.nasa.gov/gss/tutorials/fits The tutorials provide detailed descriptions of these formats, their usage, and supporting software tools. They are directed at new personnel needing to come up-to-speed on the use of a particular format, experienced personnel or existing or potential customers investigating which format would best meet a project's requirements, or the general public investigating ways to store data.

Image2000 Plug-Ins

We developed plug-ins for science data formats HDF, CDF, and FITS for Image2000--a cross-platform image processing system written in Java. Its



use of the Java Advanced Imaging package provides it with a base set of over 75 image-processing functions. In addition, a modular Directed Acyclic Graph (DAG) interface is provided for the iterative creation of new operations by combining and linking together existing operations. These new operations can be saved and edited so that they may be shared among the entire community of Image2000 users. This effort makes a powerful tool available to the science community as well as the educational community not usually familiar with the science formats utilized in NASA science data sets. (See 588's section).

Beowulf Cluster Benchmarking

The SDS Branch implemented a Beowulf Cluster—a low-cost cluster of workstations working cooperatively to process science data at super-computing speeds—using recycled and/or excessed personal computers as well as public domain and open source software. We expect this cluster to help us better understand how to accelerate science data processing applications for down-linked spacecraft data, process larger volumes of data, or process data in flight among a constellation of satellites. Initially, we implemented a probabilistic Neural Network (PNN) data processing algorithm and obtained 15 times speedup using 16 nodes.

Constellation Management

We have been studying the science data processing needs and concerns in the upcoming era of both nanosat and constellation type missions. As a result we developed a white paper, which provided recommendations and approaches to this new mission scenario. It is clear from an examination of the issues that the linear scaling expected from on-going advances in technology will not produce cost effective solutions, and a new paradigm will be needed. The issues must first be examined for the homogeneous instrument set; but it is expected that this will quickly turn to heterogeneous sets as equipment drifts and require heterogeneous instruments. The Branch worked with the constellation management working group, contributing to the degrades or as experiments are devised, which group's white paper and maintaining a central repository.

Office of Space Science (OSS)-Post Observation Data Processing System (PODPS) Unified System (OPUS) Testbed

The Branch recognizes the need to take advantage of existing products, such as the Space Telescope Science Institute's (STScI's) OPUS Data Processing System—an automated data pipeline processing environment. Although OPUS was developed to manage the hundreds of exposures taken by the Hubble Space Telescope each day, it has proven to be sufficiently generic for application to many other missions and projects Advanced X-Ray Astrophysics Facility (AXAF), Space Infrared

Telescope (SIRTF), and Far Ultraviolet Spectroscopic Explorer (FUSE). Therefore, we installed OPUS and Ftools (tools for creating FITS products) in the Science Data System Laboratory for use as a testbed for future projects. Our experience with installation and tests with sample data allowed us to produce a more informed feasibility study for Swift, and to demonstrate the product to the X-Ray Timing Explorer (XTE) Project Team.

FlatSat Testbed

We initiated studies of potential for on-board science data processing with the intent to demonstrate the integration of a selected science data processing algorithm into Code 588's existing FlatSat Architecture. We will want to show data volume reduced/time, process followed to integrate into the existing architecture, problems encountered, pros/cons and potential limitations on utilizing this on a future flight mission and suggest any Rough Order of Magnitude (ROM) cost savings gained. We realize that we must show a significant value-added in order for scientists to be willing to risk the loss of data or potential to correct data in the future.

Outreach

Branch members were very active in their communities. Several participated in Science Fairs at local schools and others made classroom presentations about their work. For example, one Branch member presented her work to Science/Physics classes at Poly Tech High School in Baltimore and another to DeVual High School students. Another was the National Judge for the National Association for the Advancement of Colored People (NAACP's) 23rd Annual Afro-American Cultural, Technological and Scientific Olympics held at the Baltimore Convention Center. The Branch also participated in various programs, such as the High School for High Tech—a program that actively recruits young people with disabilities and facilitates greater exposure and interest in high technology fields. A student from this program worked with one of our Branch members during the summer to develop a Web site. Another Branch member collaborated with Bowie State University on the Wide Field Infrared Explorer (WIRE) Testbed, allowing students to obtain operational experience. We also participated in the Center's annual Take Our Daughters to Work Program.

Branch members presented papers at various conferences, workshops and symposia. These include the Society for Photo-Optical Instrumentation Engineers' (SPIEs) 14th Annual Symposium, the 8th NASA Goddard Conference on Mass Storage Systems and Technologies in cooperation with the 17th Institute for Electrical and Electronic Engineers (IEEE) Symposium on Mass Storage Systems, 4th Archival Management and Storage System (AMASS) Users Group Meeting, Geographical Information Systems for Information Systems Professionals Symposium at Ohio State University, IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2000, and NASA and the Institute for Advanced Studies Conference.

The Branch has also recruited at various universities, including Towson State University and Massachusetts Institute of Technology, and career fairs, such as

the Annual Society of Women Engineers Conference.

Outlook for 2001 and Beyond

Although support for existing projects, such as ESDIS, NPP, and HST, is expected to continue for several years, we will also be allocating resources to new projects. We anticipate new work for programs related to scientific modeling, such as Living With A Star and High Performance Computing and Communications (HPCC), and for knowledge-discovery efforts such as NASA's Environment & Health Initiative and support to the Intelligent Data Understanding Project. Work is also anticipated for future projects that will require constellation management and event-responsive data collection. For these new activities the Branch would provide software engineering services and would participate in the development of interface applications. Branch personnel would likely team with members of the Advanced Data Management and Analysis Branch (Code 587) and the Advanced Architectures and Automation Branch (Code 588) to ensure the necessary mix of skills are provided to the customers. Beginning in January 2001, Branch management and staff will develop a strategic plan that will formulate a long-term roadmap for project support. The importance of the strategic planning effort is underscored by the anticipation of significant changes to the types of customers and the projects in this timeframe. Some of these include:

- A migration away from centralized ground data processing. For many future missions the Principal Investigators (PIs) will perform this activity. The Branch will thus be expected to be a center of excellence for ground data processing, and must be able to provide the necessary synergy among the diverse science projects.

- New support for developing "event responsive" acquisition of science data. Future constellations of satellites will have the ability to be triggered by predictive models and external observations for capture of specified science events.

- New support directed toward science data modeling. The Branch will assist the Earth and space scientific modeling efforts by instilling software engineering practices in the development and maintenance of codes and by designing application interfaces such that modeling components built by various institutions can interoperate.

- Development and implementation of tools for knowledge discovery of science data. Branch members will work closely with personnel from the Advanced Data Management and Analysis Branch (Code 587) to develop application interfaces for use in data mining efforts.

The Branch will continue to focus on developing internal technical projects that will help to advance the core competencies necessary for us to be successful in these areas. This will involve part-time work from matrixed staff, contractors, and teaming arrangements with personnel from other branches within the ISC.

The Advanced Data Management and Analysis (ADMA) Branch supports the Earth and space science communities by providing a wide range of high-end data systems solutions in response to technical requirements.

Management Team:
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Associate Branch Head
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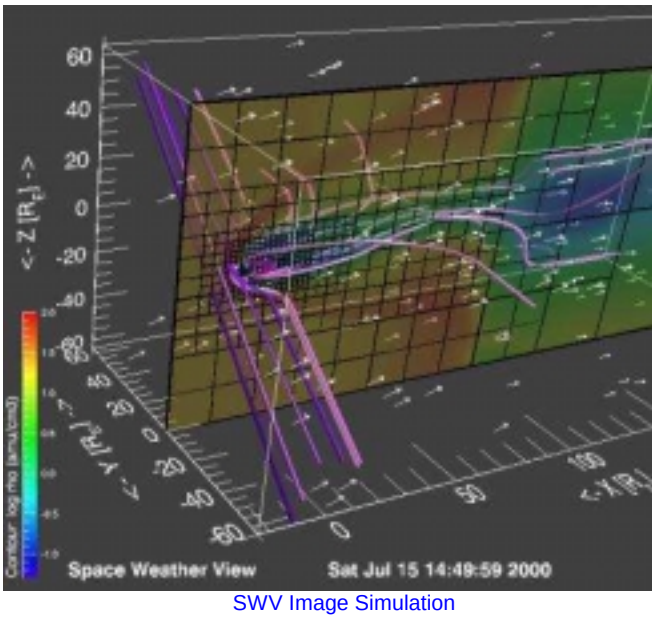
During 2000, the ADMA Branch continued to provide science data processing, analysis and visualization support to the Earth and space science Communities. Branch members were involved in a number of software development activities ranging from the production of scientific datasets to the development of scientific visualization tools for data analysis.

Space Weather View (SWV) Aids Community Coordinated Modeling Center (CCMC) Scientists

Space Weather View (SWV) is a newly developed object-oriented visualization tool that uses Interactive Data Language (IDL) object graphics to visualize in 3D output from space weather models. Currently SWV displays output from the Block Adaptive Tree Solar-wind Roe Upwind Scheme (BATS-R-US), the first model selected for study by the CCMC. BATS-R-US is a magnetohydrodynamics (MHD) code developed at the University of Michigan for massively parallel computers using adaptive mesh refinement (AMR). The output from BATS-R-US is converted to the Hierarchal Data Format (HDF5) before being displayed with SWV. In the future, SWV will be enhanced to display output from other space weather models studied by the CCMC using HDF5 as the standard scientific data format.

SWV is an interactive program providing great flexibility and usability. The user can intuitively rotate, scale or translate the view volume by dragging the mouse in the draw window. The user can view an entire volume, an isosurface, vectors, flow lines, and up to three cut planes at a time. The cut planes can be moved by dragging a slider. In addition, the animation features of SWV enable the user to view output from different time steps.

The SWV image (on the next page) is from a simulation run by CCMC scientists of the July 15, 2000 space weather event using data from the Geomagnetic Tail Laboratory (GEOTAIL) instrument. The magnetic field lines are represented by purple (interplanetary), magenta (closed), and pink (open) tubes. SWV's animation features enable CCMC scientists to analyze the changes in magnetic field topology during substorms. A meridonal cut through the density (N) distribution is shown using a semi-transparent contour plane. The adaptive computational grid is also displayed on the cut plane. The plasma velocity (V) is indicated with 200 white arrows randomly dispersed through out the volume.



SWV Image Simulation

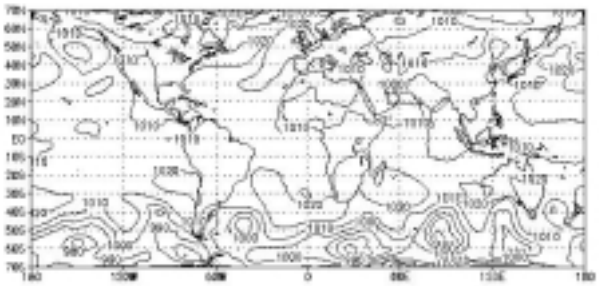
A Modified Weather Prediction Model

Working under the direction of the Earth and Space Science Computing Division, the Branch began developing a prototype to assimilate cloud data from NASA science missions into a numerical weather predicting model for performing experiments related to weather prediction over the tropics.

To develop a framework for carrying out these types of experiments, an existing regional numerical weather predicting model was modified by extending its domain in an East/West direction into a belt. The regional model was developed to run on a multi-processor system using the Message Passing Interface (MPI) for interprocessor communications. The belt version was developed from this model by modifying the domain's decomposition. Domain decomposition is the process of dividing the computational domain into small pieces, one piece for each processor, and identifying which pieces are neighbors and will need to share information. Accordingly, several routines, such as horizontal advection, which performs different calculations along the eastern and western boundaries than in the interior, were modified to account for the newly implemented zonal periodicity.

In order to run a model, one must generate a set of initial and boundary conditions. This is denoted pre-processing and it involves retrieving a global data set, extracting the data that corresponds to the region of interest, and interpolating that data to fit the domain's resolution and grid lay out. The pre-processing codes of the regional model were modified to generate a zonally periodic set of initial and boundary conditions. This was done by implementing an extended pre-processing domain, one that covered more than 360 degrees in longitude. Once the initial and boundary conditions were generated, the belt domain's data was extracted from this extended domain.

The accompanying figure is a plot of sea level pressure. Note how the contour lines at 180 degree longitude meet demonstrating the zonal periodicity of the model.



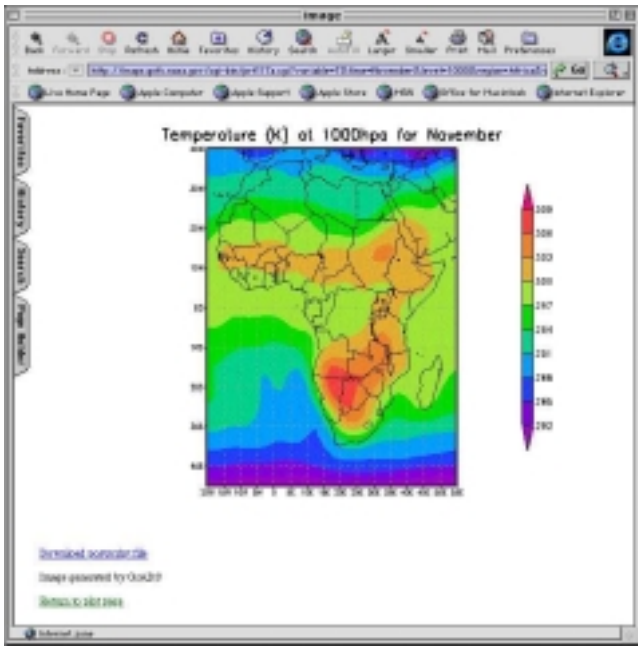
WEB-BASED ACCESS TO THE NATIONAL CENTERS OF ENVIRONMENTAL PREDICTION (NCEP) REANALYSIS DATA ARCHIVES

The Branch supported the development of a Web-based visualization application that would allow Internet users access to 40 years of NCEP reanalysis data. The 25 Gigabyte archive will be stored on the UNITree Mass Data Storage System, in a near-line environment.

This application was developed by integrating a HyperText Markup Language (HTML) user interface, Perl scripts, and the Grid Analysis and Display System (GRADS) to display the Gridded Binary (GRIB) format files from NCEP. It allows the user to download the raw NCEP data files, create single or multi-image plots, download postscript versions of the image plots, and create image animations over time. The major features of this application are:

- Downloading NCEP GRIB files
- Displaying GRADS data plots
- Downloading Postscript data plots
- Creating animations of image data plots

This screenshot is a visualization created using this Web-based application. This is an image of Reanalysis data for the temperature of Africa at 1000 millibars for November 1993.



ISC Information Systems Center Advanced Architectures and Automation

The Advanced Architectures and Automation (AAA) Branch explores, develops and promotes state-of-the-art software and networking technologies critical for improving the effectiveness, and reducing the costs, of future generations of mission data and information systems.

Management Team:

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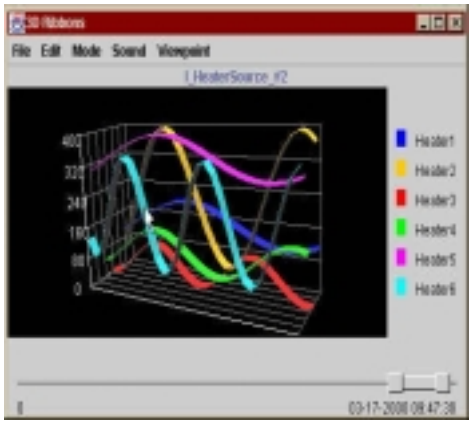
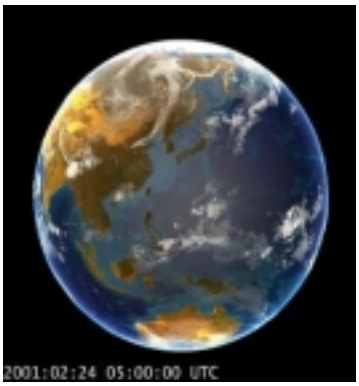
Associate Branch Head
Barbara Medina
(301) 286-4438

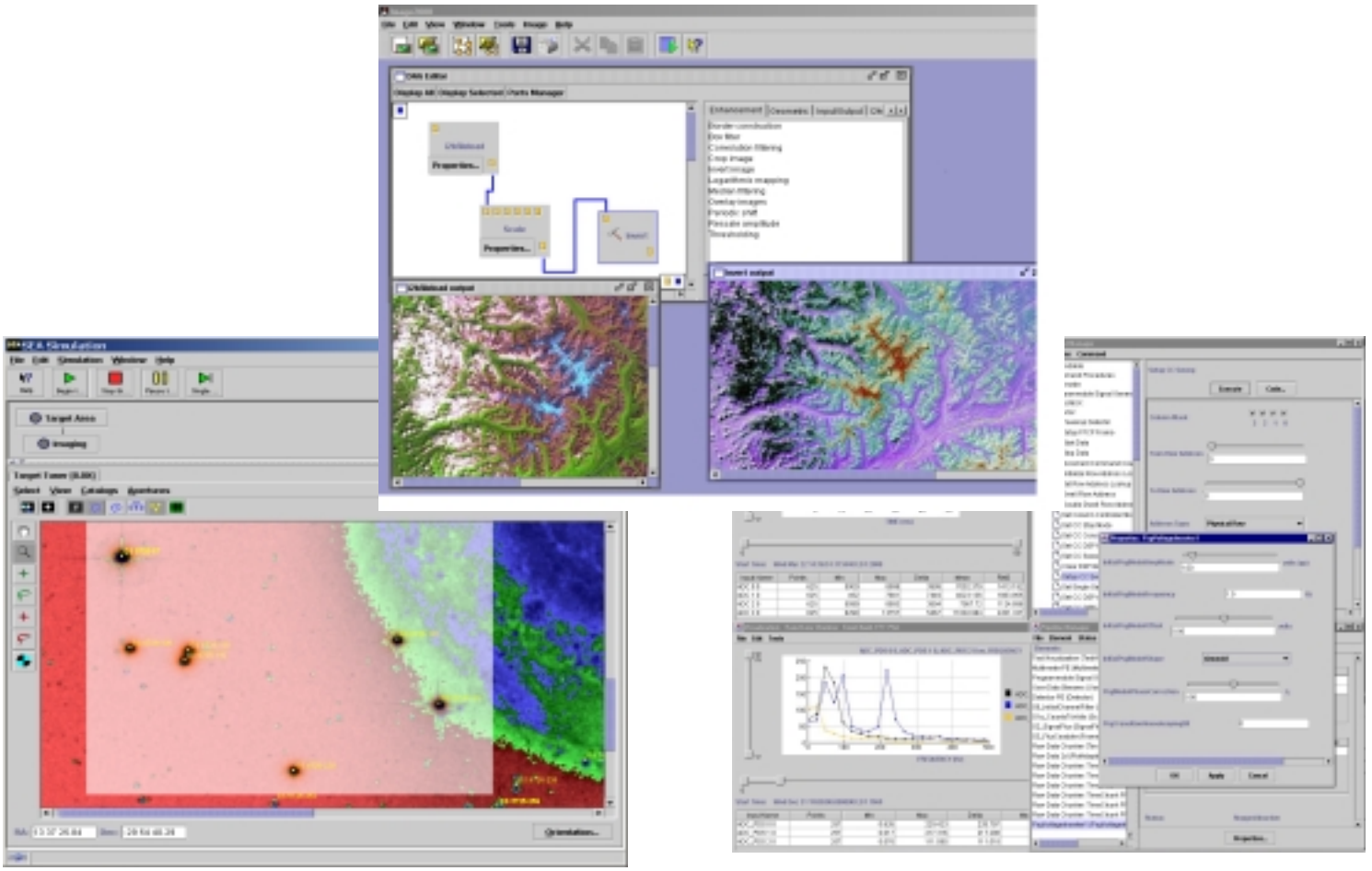
Code 588 has had a productive year developing and infusing advanced information systems technology to reduce the cost of mission control, to enable new classes of missions and to facilitate scientific work.

1999/2000 Infusion

There were many successful examples of technology infusion during the past year. The Scientist's Expert Assistant (SEA) prototype was completed and evaluated. The SEA was never planned for operational use, but due to its innovative design and advanced user-centered capabilities it has been adopted for operational use by the Space Telescope Science Institute (STScI) as well as the Stratospheric Observatory for Infrared Astronomy (SOFIA) aircraft to facilitate the specification of observation requests. The Visual Analysis Graphical Environment (VisAGE) tool was also completed and will be used by Triana and Microwave Anisotropy Probe (MAP) to provide visualization of engineering data on lightweight clients such as laptop computers. The Instrument Remote Control software successfully supported the GSFC bid for the Spectral and Photometric Imaging Receiver (SPIRE) instrument and received rave reviews from the SPIRE instrument engineers. Subsequently, the Image2000 software was completed. Image2000 is in the process of being packaged for distribution to over 5000 educators as a much-needed cross-platform scientific image manipulation tool. With its powerful capabilities,



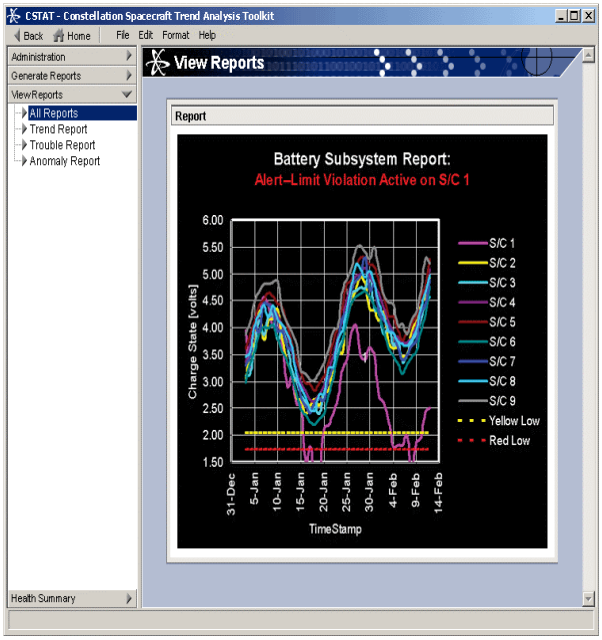


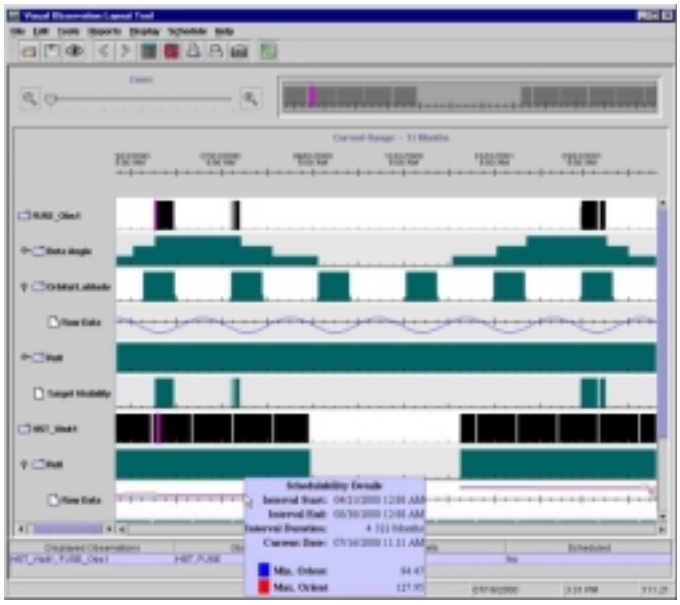


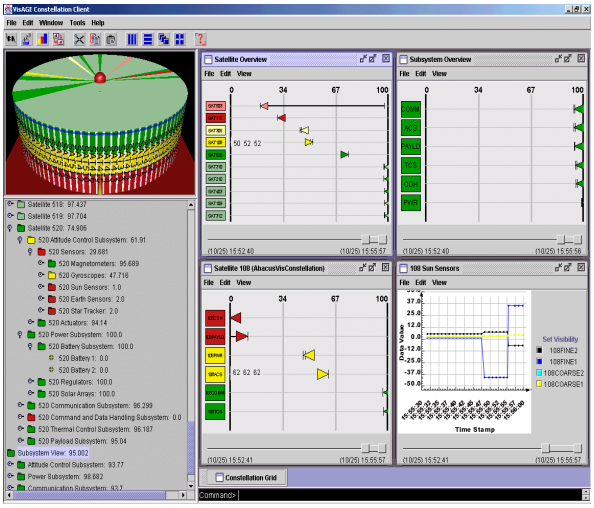
ability to run on standard desktop hardware and modular architecture, Image2000 is expected to gain many new users in various scientific domains over the next few years. The Operating Missions as Nodes on the Internet (OMNI) Project conducted successful proof-of-concept tests of pure Internet Protocol (IP) in space using the University of Surrey Satellite (UoSAT)-12 spacecraft as a space-based Web server, and issuing such commands as File Transfer Protocol (FTP) and Notice to Proceed (NTP).

2000 New Starts

Several new research projects were initiated this year. The Visual Observation Layout Tool (VOLT) Project has already proven to be very forward-thinking in its approach to creating a “virtual observatory” by transparently linking multiple planning systems to enable scientists to plan coordinated observations on multiple instruments/platforms. The Advanced Spacecraft Trend Analysis Toolkit (ASTAT) Team assessed the manually-intensive process for spacecraft engineering data trend analysis, and has begun development of a system to automate that process. The Goal Oriented Commanding (GOC)







Project, which is currently formulating the details of its operations concept, will automate the planning and scheduling by generating detailed command sequences from high-level scientific goals. The JINI Object Information Network (JOIN) Project teamed with Code 900 on a winning Chief Information Officer (CIO) proposal to provide a transparently distributed digital library for science education.

AAA Branch Kudos

Branch personnel published 19 papers in internationally recognized conferences, and presented 18 technology seminars to GSFC personnel. Troy Ames received the AETD engineering excellence award for his leadership of the Instrument Remote Control (IRC) Project. Several studies were completed to assess the current state of mission control automation, and the relative merits of alternative software approaches to automation. Lastly, Branch personnel hosted two first-ever annual workshops: Workshop on Formal Approaches to Agent-based Systems, and Joint Space Internet Workshop.

Awards and Recognition

ISC Best Technical Paper Award – 2000

The ISC Best Technical Paper Award was established in 1999 to recognize ISC employees who have written outstanding technical papers for publication in conference/symposium proceedings, journals, magazines, or books. The FY00 Best Paper Award, which includes $1500, goes to:

- Jim Rash/588 for his paper entitled, "Internet Access to Spacecraft." The paper was presented at the 14th American Institute of Aeronautics and Astronautics (AIAA)/Utah State University Conference on Small Satellites in Logan, Utah and describes Goddard's efforts in validating the use of standard Internet protocols for spacecraft communication as most recently demonstrated with the University of Surrey Satellite(UoSat-12) spacecraft

- Troy Ames/588 received the Runner-Up Best Paper Award for his paper on "Using XML and Java for Telescope and Instrumentation Control" as did Mark Stephens/582 for his paper on "Implementation of Multispectral Image Classification on a Remote Adaptive Computer"

ISC Technology Proposal Awards – 2000

Cross Enterprise Technology Development Program NRA (ISC: 2 of 11; awards/total proposals: 116 of 1400)

- *Resource Management for Real-Time Adaptive Agents* by B. Pfarr/584 and Dr. L. Welch/Ohio University

- *Constellation Management Architecture* by T. Wood/583

Earth Science Technology Office's (ESTO) Applied Information Systems Technology NRA (ISC 3 of 8; ~30/120)

- *On-Board Cloud Contamination Detection with Atmospheric Correction* by J. Miller/582

- *Adaptive Management of Computing and Network Resources for Real-Time Sensor Webs* by B. Pfarr/584 and Dr. L. Welch/Ohio University

- *Flight-Linux Operating System for Use with Spacecraft On-board Computers* by Mary Ann Esfandiari/580 (original PI), T. Miller/582 (Lead), and P. Stakem/QSS

Office of Space Science's (OSS) Applied Information Systems Program NRA

- *SEA Observation Simulation* by J. Jones/588

SOMO Technology Program (new tasks only)

- *Architecture for Constellation Management Automation* by T. Wood/583

- *Risk Analysis for Operating Spacecraft as Internet* by J. Donohue/584

- *CFDP for Improved Spacecraft Communication* by T. Ray/584

FY00 NASA CIO "Pilot Project" solicitation (of 4 Agency-wide awards, GSFC awarded 3 and **ISC on all 3!**)

- *The Web-wide World of Space, Earth and Astrobiology (WWW-SEA): A Digital Library for Science Education* by B. Meeson/900, J. Breed/588, and J. Hosler/588

- *Automatic Categorization of Project Documents from Archives* by Janet Ormes/292 and W. Truszkowski/588

- *Remote Control of Vulnerability Scanning Devices Pilot Proposing Center* by R. Schneider/585

GSFC's Technology Commerical Office – Commercial Technology Development Program

- *Multi-Function PCI Digital Data Board for Spacecraft Communications* by Sharon Orsborne/584 and Karen Keadle-Calvert/584

Awards and Recognition

GSFC DDF

- *Handheld Mars Explorer (HAMEX)* by D. Matusow/588

GSFC IR&D

- *Ocean Color Model Inversion Using an Analog, Artificial Neural Network* by Steve Bailey/584
- *Neural Network Fire Event Detection* by Jerry Miller/582
- *Hand-held Geographic Information System to Access ES Images* by Matt Schwaller/586
- *Data Discovery of Pixel Level Metadata, Pre-cursor to Datamining* by Robin Pfister/586

GSFC Annual Honor Awards – December 2000

The GSFC Annual Honor Awards were presented on December 12, 2000. Congratulations to all!

- Dennis Small/584 accepted, as Chair, The Diversity Enhancement Group Award. The work of this group is done outside the scope of normal job responsibilities.
- The Group Award for Imager for Magnetopause-Two-Aurora Global Exploration (IMAGE) Spacecraft Ground System Development Team was accepted by Edwin Fung/584

Team members include:

- Richard Hollenhurst/581
- Lori Perkins/584
- Timothy Ray/584
- Howard Dew/586

- Glenn Iona/581 received the Outstanding Leadership Award, a Group Achievement Award for Institutional Support-Infrastructure, Y2K Center Preparedness Team, Y2K Remediation Team

NASA Honor Awards – August 2000

The NASA Honor Awards were presented on August 14, 2000.

- Joe Hennessy/580 and Troy Ames/588 received the Exceptional Service Medal
- Alexander Krimchansky/581 and Ray Pages/581 were awarded the Exceptional Achievement Medal
- Alexander Krimchansky/581 accepted the Group Achievement Award on behalf of the Earth Observing System (EOS) Mission Operations System Development Team (Code 423) for which ISC supports the operational satellite Terra, Aqua, and Aura

Team Members include:

- Leigh Gatto/581
- Bob Kozon/581
- Pat Johnson/583
- Cindi Adams/584
- Karen Keadle-Calvert/584

Awards and Recognition

AETD Excellence Awards – September 2000

On September 21, 2000, the AETD Excellence Award recipients were announced at a ceremony at the Recreation Center. Our sincere congratulations to:

- Troy Ames/588 received the Engineers Award
- Manuel Maldonado/582 and Dwaine Molock/582 received and Excellence Award for the Science & Technology Advancement: New Millennium Program (NMP)/Earth Orbiter-1 (EO-1) Wideband Advanced Recorder Processor (WARP) Development Team
- Special Recognition went to Kecia Ford/580

ISC Engineering Excellence Awards - 2000

The ISC Excellence Awards were established in 1999 to recognize commitment to excellence, dedication and personal integrity in providing outstanding engineering contributions to GSFC missions. Along with a $1000 cash award comes a certificate and our congratulations to:

- Ken Rehm/582 in recognition of exceptional leadership and technical expertise as the Next Generation Space Telescope (NGST) Flight Software Senior Systems Architect
- Troy Ames/588 in recognition of exceptional leadership and technical expertise in the management, design and development of the Instrument Remote Control (IRC) Project

GSFC 1999 Honor Awards – February 2000

The 1999 GSFC Honor Awards were presented at the Goddard Honor Awards Ceremony on February 28, 2000.

- Congratulations to Team Leader Jim Rash/588 and team members Bob Connerton/581 and Gary Meyers/581 of the Operating Missions as Nodes on the Internet (OMNI) Project Team for receiving a group award in the National Resources category. The National Resources Award includes outward focused or partnership activities that demonstrate Goddard's unique role as a Federal laboratory, which result in significant scientific discoveries and/or technological breakthroughs.
- Jeremy Jones/588 received the Center of Excellence Award for leading the design and development of the innovative NGST Scientist's Expert Assistant (SEA), which is a prototype system designed to investigate automated solutions for reducing the time and effort spent by scientists and telescope operations staff in preparing detailed observatory proposals.

GSFC Quarterly Honor Awards – February 2000

The GSFC Quarterly Honor Awards were presented on February 9, 2000. Among the recipients in ISC for the Quality and Process Improvements category are:

- Art Ferrer/582 received the Customer Service Excellence Award
- Bob Sodano/581 accepted the Group Award for the Mission Robotic Automation Team. Bob was the only civil servant on the team awarded this recognition

Awards and Recognition

- Jane Marquart/582 accepted the Group Award for the Microwave Anisotropy Probe (MAP) Flight Software Team

  Team members in the Flight Software Branch (Code 582) include:
  - Maureen Bartholomew
  - Dan Berry
  - Art Ferrer
  - Alan Cudmore
  - Stephen Leake
  - Dave Leucht
  - Dave McComas
  - J. Todd Miller
  - Mark Walters

  Carolyn Dent/581 is the only ISCer outside the Branch to be included in this award

- Congratulations also to Cindi Adams/584 and Jeannine Shirley/586 who were awarded the Certificate of Merit Award

GSFC Quarterly Honor Awards – May 2000

The GSFC Quarterly Honor Awards were also presented on May 01, 2000.

- Rodney Davis/584W received the Individual Quality and Process Improvement Award for creating the Ultra-Long Duration Balloon (ULDB) "Knowledgebase"--an interactive web-accessible database containing all aspects of the ULDB flight software development effort

- Ben Keith/585 accepted the Group Quality and Process Improvement Award presented to the Telecommunication Service Request (TSR) Team

- Mary Ann Esfandiari/586 was selected as one of the winners of the Outstanding Management--First Level and Group/Team Leader Award. She is being recognized for personally embodying the Center's seven core values and instilling these values within the organization by creating a work environment that motivates employees to accomplish the Center's mission

GSFC Quarterly Honor Awards – June 2000

The GSFC Quarterly Honor Awards were again presented on June 20, 2000.

- Jeffrey Smith/585 was awarded the Customer Service Excellence Award

- Mark Walters/582 was recognized for his services as a member of the MAP Maneuver Team (originating in the Flight Dynamics Analysis Branch/572). This team worked many scenarios and contingencies for getting to the L2 orbit via fly-bys of Earth with particular thruster arrangements, and were recognized for “providing superior services or products to internal or external customers”

- Jeffrey Smith/585 and Matt Schwaller/586 received the Group Award for Institutional Support-Programmatic as members of the Earth Observing System Data and Information System (EOSDIS) Trans-Pacific Network (ETPN), Code 423. Jeff and Matt were recognized because of the cost savings of about $80K per month, plus increased bandwidth from 2 to 3 Mbps that the installed network realized

Awards and Recognition

Science and Technology Accolades!

ISCers continued to receive accolades from the many science and technology areas in the year 2000.

- Cindi Adams/584 was selected as a GOLD MEDALIST in the category of Technical, Scientific, and Program Support for the upcoming Outstanding Technical Professional Award sponsored by the Baltimore Federal Executive Board (FEB) for Excellence in Federal Career

  - Cindi also received a plaque for the "2000 President Award for Outstanding Contribution to Human Resource Development" and a plaque for "Achievement in Recognition of Outstanding Leadership" in Formulating and Implementing the AETD Minority Career Mentoring Program from Training Connection, Inc.

- Pat Johnson/583 shared in a Group Achievement Award for her excellent support on the Lunar Prospector Navigation and Mission Design Team

- Carol Boquist/587 received an Excellence in Outreach Group Award as part of the Upper Atmosphere Research Satellite (UARS) Project Science Office for the development of the UARS Brochure

- Doug Spiegel/584 won a Space Flight Awareness Award for his support of the Hubble Space Telescope (HST) servicing mission

- Jeannine Shirley/586 was selected by the Museum of Science and Industry as one of their "African-American Women in Science and Technology for the Black Creativity 2000 Exhibition"

In other award ceremonies, ISCers continued to make us proud…

- Bonnie Seaton/581, Richard Chu/585, and Steve Naus/585 received a Group Achievement Award for Institutional Support-Infrastructure, Y2K Center Preparedness Team, Y2K Remediation Team on May 1, 2000

- Cindi Adams/584 and Dennis Small/584 received a Special Act Award for serving as Program Managers for the AETD Minority Mentoring Program

- Sandy Bogan/584W received the GSFC Customer Service Award for support to the Federal Women's Program

- Joe Sparmo/585, David Matusow/585, Debbie Sharpe/585, Corrine Reed-Miller/585, Tom Weber/585 and Lisa Dallas/588 were recipients at the Chief Financial Officer (CFO) Awards Ceremony for the Integrated Financial Management Program (IFMP) and OMNI on September 13, 2000

- Congratulations to Elfrieda Harris, Booz Allen and Hamilton; Ben Keith, Code 585; and Stuart Dogger, Computer Sciences Corporation (CSC) on the recent Management Operations Directorate (MOD) Innovation Award presented to the TSR Team for their design and implementation of the TSR system, which increased productivity or improved service of the Directorate. Another great job by the Team!

- Jim Rash's/588 interview on OMNI was published in Federal Computer Week on May 1, 2000. As Project Manager Jim was also interviewed for a GSFC Press Release on the same date.

Congratulations to all ISC Award Recipients!!!

Fun Run 2000

The ISC took home the participation prize at last year's 49th and 50th 2-mile InterCenter Fun Run winning the trophey for "Best Participation" in both the Spring and Fall 2000 events. During the Spring of 2000, Szczur's Speedsters and Wheezers placed 1st in the participation competition with a membership of 85 and came in 2nd in the speed category with an average finish time of 49 minutes. We met the challenge again in the Fall of 2000 placing 1st for participation with a membership of 64 and placing 2nd in the speed competition with an average finish time of 86.3 minutes.

Congratulations go to the fastest Speedster Dave McComas/582, the winner in the men's Spring competition, finishing 8th with a time of 12:16. Steve Tompkins/581 was the fastest Speedster in the Fall event finishing 7th with a time of 12:29, and Lori Maks/588 was the big winner in the ladies competition finishing 19th with a time of 17:17.

Congratulations to the entire Speedsters and Wheezers Team!!!

ISC Speedsters and Wheezers—Fall 2000

Publications

- *NASA's Earth Observing System Data and Information System (EOSDIS) and Access to Earth Science Data* by H. K. Ramapriyan. Presented at the 1999 National Remote Sensing Conference, Application Conference and Workshop. Auburn University, AL. November 1999

- *Real-Time Information System Technology Challenges for NASA's Earth Science Enterprise* by Glenn Prescott, Steven Smith, and Karen Moe. Presented at the 1st International Real-Time Mission Critical Systems. Phoenix, AZ. November 1999

- *Implementation of Multispectral Image Classification on a Remote Adaptive Computer* by Marco Figueiredo, Clay Gloster, Mark Stephens/582, Corey Graves, and Mouna Nakkar. December 1999

- *Data Visualization via the Integration of Java Technologies* by Vincent Pell, David Fout, Ken Sall, and Matt Brandt/588. Presented at the '99 Web Engineering. December 1999

- *Using XML and JAVA for Telescope and Instrumentation Control* by Troy Ames/588, Lisa Koons, Ken Sall, and Craig Warsaw. Presented at the SPIE Symposium on Astronomical Telescopes and Instrumentation. Munich, Germany. March 2000

- *NGST's Scientist's Expert Assistant: Evaluation Results* by Anuradha Koratkar, Chris Burkhardt, Mark Fishman, Sandy Grosvenor, Jeremy Jones/588, Ray Lucas, LaMont Ruley/583, and Karl Wolf. Presented at the SPIE Symposium on Astronomical Telescopes and Instrumentation. Munich, Germany. March 2000

- *Multi-Agent Planning and Scheduling Environment for Enhanced Spacecraft Autonomy* by Subrata Das, Paul Gonsalves, Raffi Krikorian, and Walt Truszkowski/588. Presented at iSAIRS. March 2000

- *Lessons Learned from the Scientist's Expert Assistant Project* by Jeremy Jones/588, Chris Burkhardt, Mark Fishman, Sandy Grosvenor, Anurdha Koratkar, LaMont Ruley/583, and Karl Wolf. Presented at the SPIE Symposium on Astronomical Telescopes and Instrumentation. Munich, Germany. March 2000

- *Landsat-7 Science Data Processing: A Systems Overview* by Robert Schweiss/586, Nathaniel Daniel, and Deborah Derrick. Presented at GSFC. Greenbelt, MD. March 2000

- *Information Systems for Nanosatellite Constellations* by Michael Johnson, Stephen Tompkins/581, and Walt Truszkowski/588. Presented at the AIAA Space Technology Conference and Expo. March 2000

- *Expert System Technology in Observing Tools* by Karl Wolf, Chris Burkhardt, Mark Fishman, Sandy Grosvenor, Jeremy Jones/588, Anuradha Koratkar, and LaMont Ruley/583. Presented at the SPIE Symposium on Astronomical Telescopes and Instrumentation. Munich, Germany. March 2000

- *EOSDIS: Archive and Distribution Systems in the Year 2000* by Jeanne Behnke/586 and Alla Lake. Presented at the NASA/IEEE Mass Storage Conference. GSFC, Greenbelt, MD. March 2000

- *Challenges and Methods in Testing the Remote Agent Planner; Commentary on JPL White Paper* by G. Michael Tong. Presented at the 2nd International NASA Workshop on Planning and Scheduling for Space. San Francisco, CA. March 2000

Publications

- *Subsetting and Formatting Landsat-7 LOR ETM+ and Data Products* by Michael Reid. Presented at AeroSense 2000. Orlando, FL. April 2000

- *Features of an Onboard, Adaptive, Observation Plan Executive for NASA's Next Generation Telescope* by Gary Welter, Leslye Boyce/582, Lou Hallock/582, Keith Kalinowski, Ken Rehm/582, Steve Tompkins/581, Glenn Cammarata/582, Jim Legg, Vicki Balzano, Rodger Doxsey, John Issacs, and Ray Kutina. April 2000

- *Satellite Altimeter Models for Surface Wind Speed Development Using Ocean Satellite Crossovers* by J. Gourrion, D. Vandemark, Steve Bailey/584, and B. Chapron. Published in the Internal Report for "Ifremer-French Research Institute for Exploitation of the Sea." May 2000

- *Web-Altairis: An Internet-enabled Ground System* by Jason Coleman, Darren Gemoets, Kevin Hughes, and Phil Miller. Presented at SpaceOps2000. Toulouse, France. June 2000

- *Using XML and JAVA for Astronomical Instrumentation Control* by Troy Ames/588, Lisa Koons, Ken Sall, and Craig Warsaw. Presented at SpaceOps2000. Toulouse, France. June 2000

- *The MAP Autonomous Mission Control System* by Julie Breed/588, Steven Coyle/581, Kevin Blahut, Carolyn Dent/581, Robert Shendock, and Roger Rowe. Presented at SpaceOps2000. Toulouse, France. June 2000

- *Streamlining Collaborative Planning in Spacecraft Mission Architectures* by Dharitri Misra, Michael Bopf, Mark Fishman, Jeremy Jones/588, Uri Kerbel, and Vince Pell. Presented at SpaceOps2000. Toulouse, France. June 2000

- *Perl Tools for Automating Satellite Ground Systems* by David McLean, Therese Haar, and James McDonald. Presented at SpaceOps2000. Toulouse, France. June 2000

- *New Human-Computer Interface Concepts for Mission Operations* by Jeffery Fox, Sue Hoxie, Dave Gillen, Christopher Parkinson, Julie Breed/588, Stephanie Nickens/586, and Mick Baitinger. Presented at SpaceOps2000. Toulouse, France. June 2000

- *Lessons Learned on Operating and Preparing Operations for a Technology Mission from the Perspective of the Earth Observing-1 Mission* by Dan Mandl/584 and Joe Howard. Presented at SpaceOps2000. Toulouse, France. June 2000

- *Autonomy for Constellations* by Walt Truszkowski/588 and David Zoch. Presented at SpaceOps2000. Toulouse, France. June 2000

- *Autonomous Data Transfer Operations for Missions* by Max Repaci, Paul Baker, and Fred Brosi. Presented at SpaceOps2000. Toulouse, France. June 2000

- *New Paradigm For Search and Order in EOSDIS* by Robin Pfister/586 and Keith Wichmann. Presented at the IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2000. Honolulu, HI. July 2000

- Mitigating Adverse Effects of a Human Mission on Possible Martian Indigenous Ecosystems by Mark Lupisella/584. Presented at the Lunar Planetary Institute's Mars Replanning Workshop. Houston, TX. July 2000

Publications

- *Cooperative Robotics and the Search for Extraterrestrial Life* by Mark Lupisella/584. Presented at the Lunar Planetary Institute's Mars Replanning Workshop. Houston, TX. July 2000

- *A Cybernetic Approach to the Modeling of Agent Communities* by Walt Truszkowski/588 and Jay Karlin. Presented at Agents 2000. Boston, MA. July 2000

- *Internet Access to Spacecraft* by Jim Rash/588, Ron Parise, Keith Hogie, Ed Criscuolo, Jim Langston, Chris Jackson, and Harold Price. Presented at the AIAA Utah State University Conference on Small Satellites. Logan, Utah. August 2000

- *Addressing Variability in a Guidance, Navigation, and Control Flight Software Product Line* by Dave McComas/582, Stephen Leake/582, Michael Stark/581, Maurizio Morisio, Guilherme Travassos, and Michael White. Presented at the Architecture Workshop at the First Annual Software Product Line Conference (SPLC1). Denver, CO. August 2000

- *Internet Technology on Spacecraft* by Jim Rash/588, Ron Parise, Keith Hogie, Ed Criscuolo, and Jim Langston. Presented at the AIAA Space 2000 Conference. Long Beach, CA. September 2000

- *Experience Using Formal Methods for Specifying a Multi-Agent System* by Christopher Rouff/588, Jim Rash/588, and Michael Hinchey/581. Presented at the Sixth IEEE International Conference on Engineering of Complex Compute Systems. Tokyo, Japan. September 2000

- *Adaptive Management of Computing and Network Resources for Spacecraft Systems* by Ryan Detter/584, Barbara Pfarr/584, Lonnie Welch, Brett Tjaden, and Eui-Nam Huh. Presented at the 2000 Military and Aerospace Applications of Programmable Devices and Technologies Conference (MAPLD 2000). Johns Hopkins APL, Columbia, MD. September 2000

Acronyms and Abbreviations

AAA	Advanced Architectures and Automation
ACE	Advanced Composition Explorer
ACS	Attitude Control System
ADASS	Astronomical Data Analysis Software and Systems
ADEOS	Advanced Earth Observing Satellite
ADMA	Advanced Data Management and Analysis
AESE	Advanced Engineering Services & Environments
AETD	Applied Engineering and Technology Directorate
AIST	Agency of Industrial Science and Technology
AMASS	Archival Management and Storage System
AMOC	Architecture Mission Operations Center
AMR	Adaptive Mesh Refinement
APEX	Adaptive Principal Component Extraction
API	Application Programming Interface
ARTI	Advanced Range Technology Initiative
ASCAL	Automated Attitude Sensor Calibration
ASIST	Advanced System for Integration and Spacecraft Test
ASTAT	Advanced Spacecraft Trend Analysis Toolkit
ATS	Automated Tracking Station
Avatar	Advanced Visual Tools and Architectures
AXAF	Advanced X-Ray Astrophysics Facility
BATS-R-US	Block Adaptive Tree Solar-Wind Roe Upwind Scheme
BATSE	Burst and Transient Source Experiment
C&DH	Command and Data Handling
CCMC	Community Coordinated Modeling Center
CCS	Control Center Systems
CCSDS	Consultative Committee for Space Data Systems
CDA	Coordinated Data Analysis
CDF	Common Data Format
CET	Computing Environments and Technology
CETDP	Cross-Enterprise Technology Development Program
CFDP	CCSDS File Delivery Protocol
CGRO	Compton Gamma Ray Observatory
CHEM	Chemistry Mission
CIO	Chief Information Officer
CIPE	Center for Image Processing in Education
CO-OP	Cooperative Education Program
Co-PI	Co-Principal Investigator
ComPASS	Common Planning and Scheduling System
COMPTEL	Compton Telescope
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off-The-Shelf
CPU	Central Processing Unit
CSC	Computer Sciences Corporation
CSOC	Consolidated Space Operations Contract
CTO	Commercial Technology Office
DAG	Directed Acyclic Graph
DARPA	Defense Advanced Research Projects Agency
DES	Landsat-7 DAAC Emergency System
DDF	Director's Discretionary Fund
DOD	Department of Defense
DSP	Digital Signal Processing
DTAS	Data Trending and Analysis System
ECHO	EOS Clearing House

Acronyms and Abbreviations

EGRET	Energetic Gamma Ray Experiment Telescope
EMOS	Earth Observing System Mission Operations System
EO-1	Earth Observing-1
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EPAM	EXPRESS Pallet Adapter Module
EPGN	EOS Polar Ground Network
ERBS	Earth Radiation Budget Satellite
ESDIS	Earth Science Data and Information Systems
ESTO	Earth Science Technology Office
ETC	Emerging Technology Center
ETU	Engineering Test Unit
EUV	Extreme Ultraviolet
EUVE	Extreme Ultraviolet Explorer
EXPRESS	Expedited Processing of Experiments for Space Station
FACS	Financial and Contractual System
FAST	Fast Auroral Snapshot Explorer
FDS	Flight Dynamics System
FEB	Front End Processor
FFTB	Formation Flying Testbed
FITS	Flexible Image Transport System
FIU	Florida International University
FTP	File Transfer Protocol
FUSE	Far Ultraviolet Spectroscopic Explorer
FUV	Far-Ultraviolet
FSW	Flight Software
GenSAA	Generic Spacecraft Analyst Assistant
GenIE	Generic Inferential Executor
GEOTAIL	Geomagnetic Tail Laboratory
GEST	Goddard Earth Sciences and Technology
GLAS	Geoscience Laser Altimeter System
GLAST	Gamma-ray Large Aperture Space Telescope
GLIN	Global Legal Information Network
GNCC	Guidance, Navigation and Control Center
GOC	Goal Oriented Commanding
GOES	Geostationary Operational Environmental Satellite
GOSH	GRO Operational S/W H/W
GOTS	Government-Off-The-Shelf
GPM	Global Precipitation Mission
GRADS	Grid Analysis and Display System
GRIB	Gridded Binary
GRO	Gamma Ray Observatory
GSA	General Services Administration
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
HAWC	High Resolution Airborne Wideband Camera
HCI	Human Computer Interface
HCU	Hitchhiker Central Unit
HDF	Hierarchical Data Format
HENA	High Energy Neutral Atom
HESSI	High Energy Solar Spectroscopic Imager
HETE II	High Energy Transient Experiment II
HLA	High Level Architecture
HPCC	High Performance Computing and Communications
HST	Hubble Space Telescope

Acronyms and Abbreviations

HTML	HyperText Markup Language
I&T	Integration and Test
IACG	Interagency Consultative Group
IAS	Image Assessment System
ICESat	Ice, Clouds, and Land Elevation Satellite
IDIQ	Indefinite Delivery—Indefinite Quantity
IDL	Interactive Data Language
IEEE	Institute for Electrical and Electronic Engineers
IFMP	Integrated Financial Management Program
IGARSS	International Geoscience and Remote Sensing Symposium
IMAGE	Imager for Magnetosphere-to-Aurora Global Explorer
IMDC	Integrated Mission Design Center
IMM	Ionospheric Mapper Missions
IMP	Interplanetary Monitoring Platform
IP	Internet Protocol
IPIC	IP Instrument Control
IR&D	Independent Research and Development
IRAC	Infrared Array Camera
IRAD	Independent Research and Development
IRC	Instrument Remote Control
ISC	Information Systems Center
ISO	International Standards Organization
ISS	International Space Station
ISTP	International Solar-Terrestrial Physics
IT	Information Technology
ITOS	Integrated Test and Operations System
IV&V	Independent Verification and Validation
JOIN	JINI Object Information Network
JPL	Jet Propulsion Laboratory
JRTADS	Java Real-time Attitude Determination System
JSWITCH	Java-based S/C Web Interface to Telemetry and Command Handling
KM	Knowledge Management
LAARDS	L0 Active Archive Retrieval and Distribution System
LAN	Local Area Network
Landsat-7	Land Remote Sensing Satellite
LaRC	Langley Research Center
LENA	Low Energy Neutral Atom
LHEA	Laboratory for High Energy Astrophysics
LPGS	Landsat-7 Product Generation System
LPDS	Landsat-7 Product Development System
LPS	Landsat-7 Processing System
MA	Mission Applications
MADE	Mission Applications Development Environment Lab
MAP	Microwave Anisotropy Probe
MARS	Manpower Assessment Reporting System
MATLAB	Mission Applications Technology Lab
MAX	Mid-Atlantic Crossroads
MCMP	Minority Career Mentoring Program
MEDS	Multidisciplinary Engineering Development Services
MENA	Medium Energy Neutral Atom
MHD	Magnetohydrodynamics
MIDEX	Medium-Class Explorers
MOC	Mission Operations Center
MOLA	Mars Orbiter Laser Altimeter

Acronyms and Abbreviations

MOU	Memorandum of Understanding
MPI	Message Passing Interface
MSFC	Marshall Space Fight Center
NAACP	National Association for the Advancement of Colored People
NASA	National Aeronautical and Space Administration
NASDA	National Space Development Agency of Japan
NCC	Network Control Center
NCCS	NASA Center for Computational Sciences
NCEP	National Centers of Environmental Prediction
NGST	Next Generation Space Telescope
NIH	National Institute of Health
NLM	National Library of Medicine
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar Orbiting Environmental Satellite System
NPP	Net Primary Production
NPP	NPOESS Preparatory Project
NRA	NASA Research Announcement
NSSDC	National Space Science Data Center
NTP	Notice to Proceed
OMNI	Operating Missions as Nodes on the Internet
OSS	Office of Space Science
OSSE	Oriented Scintillation Spectrometer Experiment
Ops	Operations
OPUS	OSS PODPS Unified System
PDR	Preliminary Design Review
PI	Principal Investigator
PKI	Public Key Infrastructure
PNN	Probabilistic Neural Network
POCC	Payload Operations Control Center
PODPS	Post Observation Data Processing System
POLAR	Polar Plasma Laboratory (ISTP spacecraft)
POSIX	Portable Operating System Interface
PROSEDS	pro Small Expendable Deployer System
RAD	Rapid Application Development
RFO	Request for Offer
RFP	Request for Proposal
ROM	Rough Order of Magnitude
RSDO	Rapid Spacecraft Development Office
RTEMS	Real-Time Executive for Multi-Processor Systems
RTOS	Real-Time Operating System
RTSE	Real-Time Software Engineering
RXTE	Rossi X-ray Timing Explorer
SAFE	Simple Automated File Exchange
SAFS	Standard Autonomous File Server
SAFIRE	Submillimeter And Far Infrared Experiment
SAIL	Spacecraft Artificial Intelligence Lab
SAMPAX	Solar, Anomalous and Magnetospheric Particle Explorer
SAS	Service Accounting System
SASM	System Administration and Security Management
SciPro	Science Processor
SDCD	Space Data and Computing Division
SDS	Science Data Systems
SE	Spacecraft Explorer
SEA	Scientist's Expert Assistant
SEDS	Small Expendable Deployer System

Acronyms and Abbreviations

SEE	Space Environments and Effects
SEL	Software Engineering Laboratory
SERCE	Spacecraft Emergency Response Collaborative Environment
SERS	Spacecraft Emergency Response System
SEW	Software Engineering Workshop
SIE	Systems Integration and Engineering
SIMSS	Scaleable Integrated Modular Simulation Suite
SIRTF	Space Infrared Telescope Facility
SM	Servicing Mission
SMEX	Small Explorers
SN	Space Network
SOC	Science Operations Center
SOCB	Space Operations Control Board
SODA	Space Operations Directive Agreement
SOFIA	Stratospheric Observatory For Infrared Astronomy
SOHO	Solar and Heliospheric Observatory
SOMO	Space Operations Management Office
SOTG	Space Object Technology Group
SOW	Statement of Work
SPDF	Space Physics Data Facility
SPIE	Society for Photo-Optical Instrumentation Engineers
SPIRAC	South Pole Infrared Array Camera
SPIRE	Spectral and Photometric Imaging Receiver
SPIREX	South Pole Infrared Explorer
SPSR	Service Planning Segment Replacement
SSDOO	Space Science Data Operations Office
SSL	Secured Socket Layer
ST-5	Space Technology-5
STAAC	Systems, Technology, and Advanced Concepts
STEREO	Solar Terrestrial Relations Observatory
STRV	Science and Technology Research Vehicle
STScI	Space Telescope Science Institute
SWARM	Sensor Web Adaptive Resource Management
SWAS	Submillimeter Wave Astronomy Satellite
SWIR	Short Wave Infrared
SWSI	Space Network Web Services Interface
SWV	Space Weather View
TDIF	Technology Demonstration and Infusion Facility
TDRS	Tracking and Data Relay Satellite
TDT	Trajectory Design Tool
TGRS	Transient Gamma-Ray Spectrometer
TOMS-EP	Total Ozone Mapping Spectrometer-Earth Probe
TRACE	Transition Region and Coronal Explorer
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
UARS	Upper Atmosphere Research Satellite
UAV	Unmanned Aerial Vehicle's
UCAID	University Corporation for Advance Internet Development
UDF	Universal Data Format
ULDB	Ultra Long Duration Balloon
UMBC	University of Maryland Baltimore County
UMCP	University of Maryland College Park
UMD	University of Maryland
UNEP	United Nations Environmental Program

Acronyms and Abbreviations

UoSAT	University of Surrey Satellite
V&V	Verification and Validation
VET	Virtual Environment Testbed
VisAGE	Visual Analysis Graphical Environment
VLSI	Very Large Scale Integration
VMOC	Virtual Mission Operations Control
VOLT	Visual Observation Layout Tool
VTT	Visual Target Tuner WFF Wallop Flight Facility
WEVAC	Wearable Voice-Activated Computers
WICC	Wallops Integrated Control Center
WIND	Solar Wind Mission - An interplanetary spacecraft of ISTP
WIRE	Wide-Field Infrared Explorer
WSC	White Sands Complex
WWW	World Wide Web
XRS	X-Ray Spectrometer
XTE	X-Ray Timing Explorer


ISC
Information Systems Center